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SIXTH NATIONAL COLLOID SYMPOSIUM

The National Colloid Symposium has accepted the invitation of the University of Toronto to hold the Sixth Symposium there on June 14th, 15th, 16th, next. The guest of honor at this meeting will be Sir William Hardy of Cambridge, England. Professor Hardy may be considered the pioneer of modern colloidal chemistry in England; for a number of years he was a Secretary of the Royal Society of London, and has gained an enviable position in the scientific world by his first-class scientific work and pleasing personality.

The Local Committee desires to draw the attention of all interested to two innovations which it is hoped will add materially to the interest of the meeting:

(1) Since the experience of other Societies shows that the provision of abstracts of the papers in advance greatly stimulates discussion at the meetings, arrangements have been made with the publishers of *Canadian Chemistry and Metallurgy* to print a special Supplement to their June issue which will contain complete abstracts of all papers contributed to the Symposium. Advance copies of this Supplement will be mailed to all who indicate their intention of attending the meeting.

(2) Arrangements have been made for an Exhibition of Experimental Methods in colloidal work; a large hall has been secured adjoining the building in which the Symposium will be held, and space will be offered free for exhibits accepted by the Local Committee. It is thought that in this way workers in colloids may be enabled to bring to the attention of their colleagues many details of experimental arrangement and technic which are necessarily crowded out of the limited program of papers; it is hoped that those presenting papers at the Symposium will accept this opportunity of displaying the apparatus used in their work and that others with novel types of apparatus will take advantage of the opportunity to exhibit them.

Suitable arrangements will be made with the Customs authorities of both countries to facilitate the passage of such apparatus over the border; full details may be obtained from Professor E. F. Burton, Department of Physics, University of Toronto.

On behalf of the University of Toronto, the Local Committee extends to all interested a hearty invitation to attend the Symposium; communications with regard to any of the local arrangements may be sent to the Secretary or to any of its members.

UNITED STATES CIVIL-SERVICE EXAMINATIONS

The United States Civil-Service Commission announces an open competitive examination for Junior Technologist, $1860.

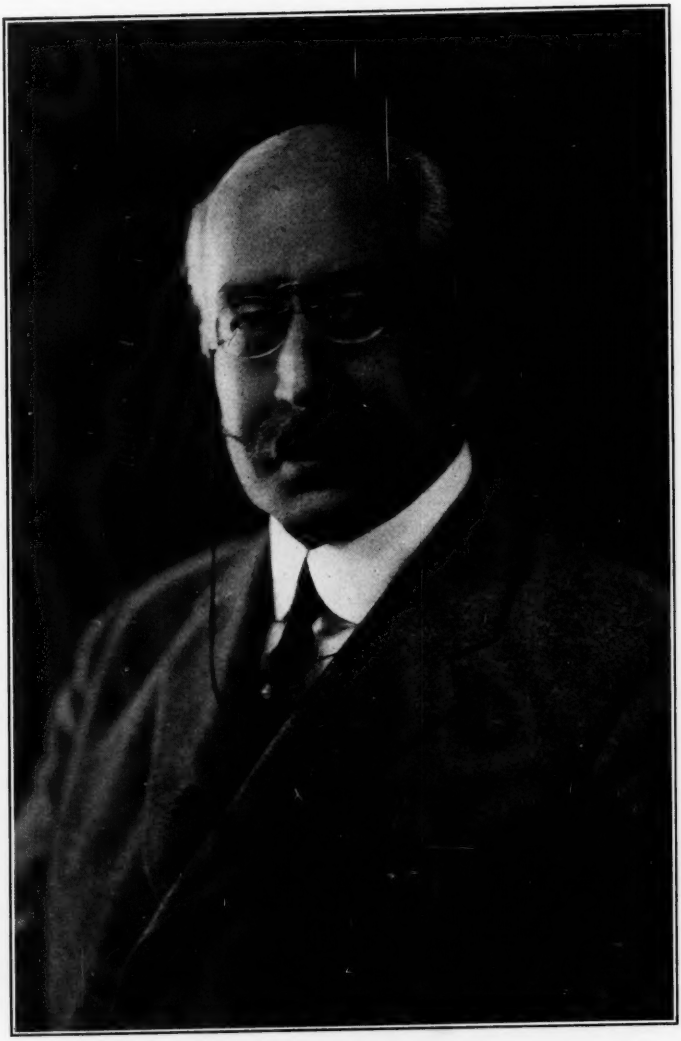
Applications must be on file with the Civil-Service Commission at Washington, D. C., not later than April 28th. The date for assembling of competitors will be stated on their admission cards, and will be about ten days after the close of receipt of applications.

Optional subjects are ceramics, paper technology, petroleum technology, rubber technology, and textile technology.

There are vacancies in the position of junior petroleum technologist in the Geological Survey for duty in the States of California, Colorado, Montana, New Mexico, Oklahoma, Utah, and Wyoming.

Competitors will be rated on general chemistry, elementary physics, and mathematics up to and including calculus; and practical questions on each optional subject chosen.

Full information may be obtained from the United States Civil-Service Commission at Washington, D. C., or the secretary of the United States civil-service board of examiners at the post-office or customhouse in any city.



MARSTON TAYLOR BOGERT

EDITOR'S OUTLOOK

IN THE February number we published the first of a series of three non-technical lectures which Dr. Bogert delivered at The Charles University of Prague in the capacity of first Visiting Carnegie Professor of International Relations to Czechoslovakia. This month we are privileged to present another of that series.

Marston Taylor Bogert

Although Dr. Bogert's achievements in the realm of pure science have earned for him an enviable and well-merited distinction, it is perhaps in the field of public service that his contributions have been unique. It will be remembered that he was, by invitation of President Roosevelt, a member of the White House Conference on Conservation of Natural Resources in 1908 and of the Conference with Governors of all States and Territories at the close of the same year and that President Wilson offered him an appointment (which was declined) to the U. S. Tariff Commission. During the war he was a member of the General Munitions Board, the War Industries Board, the U. S. Board on Gas Warfare and numerous other boards of a like nature; acted as consultant to the U. S. Bureau of Mines, the U. S. Bureau of Standards, the U. S. Federal Trade Commission and other government departments and bureaus, and served on advisory bodies too numerous to mention. In March, 1919, he was commissioned Lt.-Colonel and appointed Chief of the Chemical Service Section, National Army, and Assistant Director (Acting Director) of Gas Service. Upon organization of the Chemical Warfare Service he was promoted to Colonel and assigned as Chief of the Relations Section and Intelligence Section. He also served on many of the Chemical Warfare Service boards and committees. Dr. Bogert is at present a member of numerous consulting and advisory bodies, both municipal and national.

On delving into the records we find that Dr. Bogert's maturer life has but fulfilled the promise of his student years. In addition to maintaining a phenomenal scholastic average throughout his collegiate career he found time to take a leading part in student affairs (as evidenced by the many offices he held) and to make a creditable showing in athletics.

It is not recorded of Dr. Bogert as of Crum Brown that he was ever offered the choice of three chairs in a University, but some indication of his versatility is seen in the fact that he refused a post as Assistant in Germanic Languages in order to pursue the study of chemistry. Eventually he was appointed first Professor of Organic Chemistry at Columbia.

In view of Dr. Bogert's keen interest in public affairs and his well-demonstrated ability for meeting and dealing with people, it is not surprising that he should have been chosen as first Carnegie Professor to Czechoslovakia. For the holder of a Carnegie professorship must be

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much more than an authority in his subject. He must adopt the rôle of an unofficial ambassador, a good-will emissary, whose duty it is to demonstrate that America is not entirely populated by the money-grubbing materialists of the European cartoons—that we occasionally, at least, produce gentlemen and scholars.

We are happy to learn from European sources that Dr. Bogert's mission in that respect accomplished all and more that could have been expected. The impression which he created was everywhere favorable and his contribution toward the cementing of good international relations is not to be lightly estimated. May more men of his type be found to continue the work which he has so ably initiated!

A Chemist's Baedeker

DR. HOLMES' note on "The Street of the Alchemists," which appears elsewhere in this number, suggests that Europe must contain many such interesting but out-of-the-way spots that the visiting chemist is scarcely apt to happen upon except by accident. In this day of cut-rate summer passages it is not entirely beyond the bounds of reasonable expectation that even an occasional teacher of chemistry may realize the long-cherished dream of a trip to the Old World. Hence, for the benefit of those who are still planning such tours, as well as for those of us who do most of our traveling via the *National Geographic*, the editor solicits similar notes and suggestions from more experienced travelers. If the volume of response seems to warrant it, it is the intention to prepare a brief article enumerating some of the points of interest which chemists might desire to include in their itineraries. Perhaps, later, it may be possible to compile a similar guide for the "see-America-first" tourists.

Dean Kendall Resigns

THOUGH American chemists cannot but regret the removal from their midst of so distinguished a scholar as Dean Kendall of New York University, they may derive some satisfaction from the thought that America is now able to lend to as well as borrow from Europe in matters of scholarship. It is true that Dr. Kendall is but returning to his old alma mater, Edinburgh, to accept the chair of chemistry made vacant by the retirement of his former teacher, Sir James Walker; yet it is as an American chemist that he has made his mark.

Dr. Kendall was for a number of years professor of chemistry at Columbia and is well known to readers of the JOURNAL as one of its contributing editors as well as through his researches and his texts.

We wish him all contentment in his new undertaking.

SCIENCE IN THE INTEREST OF PEACE*

MARSTON TAYLOR BOGERT, COLUMBIA UNIVERSITY, NEW YORK CITY

One obvious remedy for war is the disarming of the trouble-makers, so as to render it difficult or impossible for them to make war again successfully; and thus to release the peaceful and peace-loving nations from the necessity of maintaining large war establishments, and to return to more productive pursuits that portion of the population previously diverted to military occupations. This will also lighten the burden of taxation. It follows then that the point to which the peace-loving nations can successfully reduce their armaments will be determined by the extent and effectiveness of the disarmament imposed upon the aggressive ones.

Practical successful disarmament is an exceedingly difficult and complicated problem, whether undertaken voluntarily or imposed by superior force, and changes as weapons and methods of warfare change. The less one knows about it the simpler it appears. Such ignorance is not necessarily or always to be ascribed solely to the man in the street, who at least would have the valid excuse that warfare and disarmament were not his business, but not infrequently is found in the case of military men who are slow to recognize the fact that the warfare of today is totally different from what they learned at the military school, and that the future may and is quite certain to witness still more startling changes.

As science advances, warfare changes. Methods of fighting inconceivable to our ancestors occupy the center of the stage today, and future wars will see still other methods employed of which we do not as yet dream. Each succeeding conflict, qualitatively if not quantitatively, will be more terrible than its predecessors. One by one, man's fighting weapons have been rendered obsolete by the appearance of new and more potent ones, or ineffective through the development of adequate defense. The bow and arrow displaced the war club and grew into the cross-bow; but the archers were put out of business by the introduction of body armor, which lost its value in turn through the discovery of gunpowder and firearms. The contest between artillery and above-ground fortifications was decided definitely in favor of the former in the early days of the war, and men sought refuge in trenches and dugouts, there to be asphyxiated by the poison gases later employed, until protection was supplied by gas masks and dugout blankets. But the operation of land and sea forces is now subject to domination by the military forces in the air, and it has already been actively argued that airplanes and submarines together have made huge and enormously expensive battleships an anachronism, since a single tor-

* The third of a series of three non-technical lectures delivered at The Charles University, Prague, by Dr. Bogert in the capacity of first Visiting Carnegie Professor of International Relations to Czechoslovakia.

pedo from either source, properly placed, means an end of the vessel with all on board.

In the early dawn of the race, disarmament might have involved only sequestration of war clubs, but if it had resulted in the production of bows and arrows little would have been accomplished in the direction of peace. In 1862, naval disarmament would have meant reducing the number of wooden fighting ships. No one dreamt of ironclads; but in the same year the Merrimac destroyed the Union Fleet in Hampton Roads and made it unnecessary to disarm wooden ships, for the advent of the steel battleship had eliminated them immediately, only to become itself today the prey of the airplane and the submarine.

And so throughout the long march of misty centuries scientific invention and discovery have continually changed the meaning of disarmament, and this will undoubtedly continue until the last chapter is written and the book is closed.

Of the many aspects of disarmament, the one which appeals to me as most appropriate for our consideration this afternoon is: "What would the scientist regard as really effective disarmament?"

Some answer to this may be found by tracing first those factors which determine a nation's power in war. As our consideration must be of the briefest, it will perhaps suffice to discuss this under the general headings of (1) material resources and (2) human resources. Under each of these major headings there will be again a host of diverse items varying in relative importance, as the nations themselves differ in racial characteristics.

As the effective force of a nation is an additive function of these separate factors, it is quite possible for a country with a huge population, like China for example, to have so low a rating on the other factors involved, as to be totally out-classed by a nation like France, with but a fraction as many people, and any scheme of disarmament must therefore take all these factors into consideration in deciding upon the most effective plan for a given country.

Disarmament and Material Resources

Under the caption, material resources, would fall all that original endowment which we are accustomed to associate with the name "natural resources," a field in which science is easily a dominant figure in transmuting such raw material into articles which serve man's needs.

Among the innumerable items here, I have selected but a few, choosing them either because it seemed to me that they should be emphasized, or in other cases because there was a likelihood of their being completely overlooked.

An extra-terrestrial resource, the sun should not be neglected in our calculations, for Pritchett has made the statement that on a clear

day, when well above the horizon, the sun delivers on every acre the equivalent of 7500 h.p., working continuously; and those of you who attended the World's Exposition at St. Louis, many years ago, may recall the Portuguese Priest's heliophore there exhibited, in which by an ingenious combination of burning glasses a temperature of 3000°C. was attained—a heat so intense that a cannon ball exposed to it would melt like a snowball on a red-hot stove. The chemistry of the photosynthesis realized in plants is but little understood and more scientific light as well as sunlight, in this branch of chemistry, might completely revolutionize agriculture.

Were time available, I would like to trace for you the complete dependence of modern agriculture upon chemistry. It will suffice here perhaps to point out that the starches, sugars, and other vegetable products upon which animal life is dependent owe their origin mainly to such simple molecules as carbon dioxide and water which, with the assistance of the energy supplied by the sun, are slowly elaborated into foodstuffs in the plants' cells. It has been pointed out in previous lectures that the chemist today can make, and is making in a few moments' time, innumerable dyes, drugs, and perfumes absolutely identical with those which nature produces only after months of effort. Why may he not likewise discover how to make our foods with equal speed and efficiency from the same simple molecules as nature employs? He not only may, but he certainly will, for the chemistry involved is simple and the first steps have already been taken. When that goal is reached, manufacturing nations will not be so dependent upon agricultural ones, or require so much land for the support of their populations.

Little Holland has made far greater use of the wind as a source of energy than have we, and there still remains the immense power available in the rise and fall of the waves and in the tides.

Since coal is one of the most important factors in the life of all modern industry, restriction of the amount of coal allotted to a country is one of the most potent and crippling forms of disarmament, for it immediately limits the possibilities of industrial expansion in nearly every direction. Limitation of the amount of water power to be developed would be equally crippling to other countries. Restriction of both would tie any nation hand and foot.

Next in importance come such natural resources as iron, copper, lead, zinc, and other metals, so far as mineral deposits are concerned, but the output of all is dependent upon the availability of power. Motor transport must look to the petroleum distillates for fuel and such transportation is tremendously important in war time.

In the field of natural resources then, scientists will agree, I believe, that the most effective disarmament of a nation would be that resting upon control of such prime sources of energy as water power, coal and oil.

In so far as the ordinary metals are concerned, it would only be necessary then to see that a nation be not permitted to accumulate, in excess of normal peace requirements, large stocks of such as have peculiar war value, or surreptitiously to gather up the world's small floating supply of those rarer metals, like platinum for example, which are often of tremendous technical significance.

Disarmament and Human Resources

An attempted analysis of human resources would prove both exceedingly difficult and time-consuming, if undertaken with any thoroughness, for it includes such matters as population, progress in civilization, governmental form and stability, industrial organization and efficiency, the proficiency of the people in science especially, and of the hosts of other problems falling within the domain of the sociologist. A few of these problems, more or less germane to the scientist, may be considered superficially, more with the idea of pointing out the complexity of the task than with the thought of making any valuable contribution to their solution.

POPULATION

A very positive method of disarmament is that which reduces or restricts the population of a belligerent. In ancient times, this took the form of destroying all the males, or else the total extermination of the nation. For example, (I Sam. xv: 2–3) Samuel delivered the following message to Saul: "Thus saith the Lord of Hosts, I remember that which Amalek did to Israel, how he laid wait for him in the way when he came up from Egypt. Now go and smite Amalek, and utterly destroy all that they have, and spare them not; but slay both men and women, infant and suckling, ox and sheep, camel and ass;" and because Saul spared some of the best of the livestock, he lost his throne and died a suicide.

As we have not yet sunk back so far as those barbarous days, or reached the point where a wholesale annihilation of a definite percentage of a nation is conceivable as a method of disarmament, or where the growth of a population can be compulsorily restricted to an established subnormal rate, there remains the very important matter of preventing a belligerent nation from increasing its man-power by accretion from without, namely, by taking possession of additional territory with the population thereon.

In the absence of voluntary or imposed restriction of population, rapid increase might be brought about through improved hygienic and sanitary measures and ability to combat successfully all known diseases, due to an advance in medical science not known perhaps to the rest of the world, resulting not only in a lower death rate but also in increased longevity. Nor is it impossible that the secrets of birth control might be so far revealed

as to result in a much larger proportion of males, in this way increasing the man-power of the State.

INDUSTRIAL ORGANIZATION AND EFFICIENCY

Industrial organization and efficiency were entitled to exceptionally high ratings in Germany at the outbreak of the World War, and they proved to be the backbone of the German military power. These are themselves the resultant of many complex forces—natural resources, education and ability of the individual, attitude of the Government, and the like.

In a few cases, like that of the Krupp Plant at Essen before the War, a factory may be characterized at once as primarily a munitions plant, but in the majority of cases the peace plant of today is the war plant of tomorrow and, as stated above, it is this possibility which complicates our problem of disarmament so greatly. Factories regularly manufacturing firearms, artillery, war planes, etc., present no serious difficulty, as they can be reduced in number or curtailed as to output without interfering so seriously with the peace needs of the people. The answer is not so obvious in the case of plants used for peaceable industry as well as for war. Let us consider a few of this latter group which are of immediate interest to the chemist.

1. *Explosives:* The source of all modern propellants and bursting charges is nitric acid, formerly prepared chiefly from Chilean saltpetre, and now mainly from atmospheric nitrogen or from the ammonia of the gas and coke manufacturers. As has been mentioned, explosives have their peaceful uses also, in mining, irrigation and engineering works, and to a less degree in other industries, although the particular substances used may not always be the same in the two cases. The accumulation of large stores of such explosives or initial materials as have high war value and but little use in industry might be restricted. Nitrate is essential not alone as cannon fodder, but also as food for plants. The agriculture of the country, therefore, depends to a considerable extent upon an adequate supply of nitrogen in a form valuable for plant food, but it should not be lost sight of that vast nitrate capacity means vast capacity for the manufacture of explosives.

2. *Toxic Gases:* The manufacture of poison gases has been associated almost wholly with the production of synthetic dyes and related compounds, since most of the products employed for the purpose are organic, the technic and equipment required are similar, and the chemical knowledge necessary much the same, and this is why a synthetic dye factory has been called a "potential arsenal." Germany's dye plants became munition factories almost over night. There would be, therefore, the same justification for restricting abnormal development in this field as in that of

the erection of nitrogen fixation units. The poison gases used in the largest amount during the war were chlorine, mustard gas, phosgene, diphosgene (palite and super-palite), chloropicrin and diphenyl-chlorarsine; all of them either products of the dye factories or which counted these factories as their largest consumers.

It was the need of the manufacturers of synthetic indigo for large amounts of chloro-acetic acid which made such heavy demands for chlorine that it became necessary to develop the electrolysis of salt, and the vast supply of chlorine thus made was used with terrible effect in the first gas attack of war, April 22, 1915, in the Ypres Salient. Phosgene was a regular article of manufacture for pharmaceuticals and for the Michler's ketone from which many important dyes were prepared. The others mentioned were turned out solely as war gases by the dye factories.

SCIENTIFIC STATUS

By this is meant both the education and proficiency of the individual in science, and the attitude of the nation towards science in general. Inferiority in population and in endowment of natural resources may be more than counterbalanced by progress in science and in industrial organization and efficiency, as already mentioned. As man's knowledge of scientific law grows, his power becomes less and less dependent upon mere numbers of population or upon a complete supply of natural resources.

To recapitulate then, effective disarmament in the opinion of the speaker must cover the following points:

I. Disarmament in the absolute sense of reducing stocks of all known implements of war, munitions, etc., and so far as practicable the manufacturing capacity for the same, whether it relates to warfare on land, water, or in the air, so as to include all chemical warfare munitions, the fixation of atmospheric nitrogen, submarines, and airplanes. In matters essentially chemical, it must provide for the definite restriction and control of: (1) such primary sources of energy as water power, coal, and oil, without which large industrial expansion in any direction is impossible; (2) the fixation of atmospheric nitrogen, the mother-substance of all modern explosives; and (3) the synthetic dye plants, the source of all poison gases, and the actual manufacturers of most of the explosives used in war. Exports of such materials also should be very carefully regulated or completely banned, for export trade is the favored excuse for the maintenance and expansion of colossal plants of latent war possibilities. The same Disarmament Commission might be very keen for the dismantling of a great artillery works and yet ignore completely the continuance and expansion of mammoth arsenals, camouflaged as dye factories or agricultural chemical works, although the actual disarmament effected might be much

greater were the dye and nitrogen factories restricted than if the military plants were razed.

II. Disarmament in the relative sense of equivalent or superior armament in those directions where actual reduction of war power is deemed impracticable or not readily obtainable.

Effective disarmament predicates occupation of the enemy's territory, or of strategic points therein, and ceases with the evacuation of that territory. Where disarmament is a matter of voluntary international agreement, and not in the nature of a punitive measure, as much or as little of the above program can be adopted as seems desirable.

At the beginning of man's history upon this planet, the struggle against his environmental enemies did not differ radically from that of other mammalia of that era, nor had he much more control over the forces of his universe. As a reasoning creature, however, he soon learned from experience, and this fund of experience, passed on from generation to generation and steadily augmented, has given him an ever-increasing knowledge of the laws which govern our little world and how they can be made to execute his will.

The caveman with his few simple weapons, even when an Hercules in strength, could not have killed more than a handful of men at a time, even under the most favorable conditions. If we accept the biblical narrative literally, rather than allegorically, Sampson killed one thousand Philistines at Ramath-Lehi with the jawbone of an ass, and in pulling down the temple of Dagon at Gaza killed several thousand more, himself included. Such feats represent the maximum destruction accomplished by unaided brute strength, yet how insignificant they appear when compared with the possibilities controlled by even physically puny present-day mortals.

What the future holds, no one can foresee. Chemical warfare is evidently only in its infancy, yet in some of the major bombardments by the Germans during 1918, as high as eighty per cent of all projectiles thrown over carried poison gas, and the conclusion seems justified that hereafter shells used against troops will always contain toxic gas of some kind. Naturally, the distribution of such material is not limited to its use in artillery shells, as it may be conveyed to the enemy in any kind of container from the aerial torpedo down to the cylinders which release it for a drift gas attack. Further, it will be employed in naval and air engagements, as well as on land. At any moment, the chemist may discover a gas of such tremendous toxicity that minute amounts of it will render large areas uninhabitable, and which will at the same time penetrate any known mask. If he can also provide his own troops with masks that will stop this gas, the armies of the other nations will be practically at his mercy until they too can devise a defense against it.

Or the physicists may learn how to hurl wireless annihilating thunder bolts through the air at the rate of hundreds of miles per second. The fundamentals of such a machine were patented in 1915 by Nikola Tesla (U. S. pat. No. 1,119,732). Claims have been made frequently by various inventors that mines or the magazines of war vessels, ammunition dumps, etc., can be exploded by wireless waves projected against them from points many miles away. Suppose that one of these days a similar claim proves true?

The fortunate discovery of radium revealed to us, as one of nature's inmost secrets, an element disintegrating at a measurable rate, its average life being estimated at 2500 years. Attention directed to a study of this phenomenon has shown that other elements also are disintegrating although at widely varying rates, radium emanation having a life of about a few weeks, while uranium lasts for billions of years. Probably all elements are undergoing similar changes, although with many of these the velocity is so low as not to be detectable. It has been calculated that the energy dormant in a pound of uranium is equivalent to at least that liberated by burning 185 tons of coal, and that the energy in a ton of uranium would suffice to light London for more than a year. No way has yet been found to accelerate these rates of disintegration so as to release these vast stores of energy. Therein lies the problem, the solution of which means also the transmutation of the elements. Such transmutation rests upon the power to unlock this internal energy of matter and strangely enough the release of these stores of energy would be infinitely the most important and valuable result of transmutation, for man's whole life has been described as a struggle to wrest from nature some of her stores of energy. Were the key to this secret powerhouse of Nature some day to fall into the hands of a scientist, the fate of the human race would rest largely with him. Think what it would mean to aviation to have a fuel which would give per pound the energy equivalent to 185 tons of coal, or how a few pounds would run our factories, battleships, etc. Suppose that a 100-lb. bomb of uranium, equivalent to 18,500 tons of coal, were dropped from an airplane upon a city and the entire energy liberated at the instant of impact; or that an aerial torpedo were devised whose atomic disintegration could be induced at such a rate that it would keep on exploding incessantly and wherever it fell would create a veritable inferno of continuously spouting flame, what terrible devastation would be wrought. An idle nightmare, you say? Yes, just as foolish as telegraphing or telephoning without wires would have been regarded a few years ago. To the scoffers, I would recommend Soddy's "Interpretation of Radium," or H. G. Wells' somewhat lurid novel, "The World Set Free."

What else? Will medical and biological warfare accompany or follow chemical and physical warfare? Who knows? If they should, they

may prove still more destructive. There is no danger to be feared from the larger forms of animal life, for they all recognize man as their master, but in the incalculable billions of lower forms of life man finds his most dangerous and most implacable foe and one which may yet destroy him.

But this is not a pleasant subject to discuss, particularly in a country where the terrible experience of the last war must still be vivid and poignant in the memory. My sole purpose is to emphasize what that war made clear, namely, that the wars of the future are going to be decided more and more in the laboratories and research institutions of science and less and less merely by the movement of masses of men. The military argument based upon the movement of masses of men is valid only when the opposing armies are similarly equipped with both offensive and defensive appliances, an assumption which may be and probably will be at wide variance with the facts. Against an enemy fully equipped with air and chemical warfare services, what chance would an army stand if not similarly equipped? Such an unprotected army would be more helpless than a band of savages armed with bows and arrows against a machine gun company.

David used his head as well as his sling against Goliath. Hannibal's elephants struck terror to all hearts until some man with a head suggested the use of arrows carrying tips of flaming tar, with the result that a wild stampede of elephants ensued. In the struggle of brain versus brawn, or science versus ignorance, the final result is never long in doubt. Napoleon Bonaparte is credited with having said: "There are but two great forces in the world, the sword and the brain and, in the long run, the sword is always beaten by the brain."

In what ways then can science serve the interests of peace, in addition to indicating effective methods of disarmament?

Nations are not different from their individual units and, like them, occasionally start a fight to rob someone of something they want, be it additional territory, coast line, natural resources or something else, on the excuse that these things are necessary for their own welfare, expansion and development. Huge sums are spent on offensive and defensive preparations, and but little thought is given to the likelihood of revolutionary discoveries by scientists bearing upon war, or to the possibility of calling upon science to find a way of accomplishing what is desired without going to war about it at all.

The cost of a single battleship in the United States, about $30,000,000, would build and equip as fine a scientific research institution as the world has yet seen, and the annual upkeep of such a vessel in commission, say $3,000,000, would take care of the running expenses of the aforesaid research institution. Conceivably such an institution, if devoted to problems affecting the public safety, within a few years might render present-

day warfare obsolete. It is admitted that nations must protect themselves to meet the type of warfare in vogue, but it seems to me, even from a military point of view, that it would be far more advantageous to discover and develop new weapons and new methods of offense and defense, rather than merely to elaborate existing methods and munitions, or, to put it somewhat differently, why not try science as war insurance? Of how much defensive value today is the Great Wall of China? If the other nation has something you want and don't possess, give your scientists a fair chance first, to see what they can do to meet this need, before you start a war.

If the claim is made that more land is necessary to feed the population, make sure first that the land available is giving the maximum return and then speed up the possibilities of synthetic foods.

Once or twice, nations have been near war over the possession of oil fields, although science might have then, and has since, shown how oils can be prepared from coal and hydrogen, or from carbon monoxide.

In the absence of coal mines, water power can be developed and the energy distributed in the form of electricity. Where neither coal nor water power are available, as in the Sahara Desert, for example, the possibilities of utilizing the sun's heat are worth considering. When certain natural resources are lacking, others often may be made to take their place. Think of the extent to which concrete has already displaced other building materials, the part played by aluminum, by bakelite and synthetic substances of all kinds. If you are losing business in the markets of the world, do not go to war about it, but spend an infinitesimal fraction of the cost of such a war upon your research laboratories and your scientific men, and the results are certain to be much better for you and for the rest of the world.

In the wonderful opportunities offered by science, there is so much to be done which is not only worth doing, but likewise absorbingly interesting and fascinating, that the only rivalry between individuals or nations should be as to who can serve humanity and civilization most and best.

Ancient Salt Mines Discovered in Austria. Salt mines that were operated on an extensive scale, with very "modern" shafts, tunnels, and drifts, more than 500 years before Christ, have lately been explored near Hallstadt, Austria, by Dr. Adolph Mahr of the Vienna State Museum. In addition to knowledge of the mining methods of these prehistoric men of the early Iron Age, the exploration yielded also numerous articles of leather and wood, well preserved against decay during the ages by their burial in salt. These finds included pick handles, torches, wedges, mine timbers, felt caps, shoes of wood, leather, and felt, leather hand-protectors, and many other articles.

The exploration was backed by two Americans, Prof. F. W. Bade of the University of California, and Major Gotshall.—*Science Service*

EMERSON AND CHEMISTRY.* PART II

CHARLES ALBERT BROWNE, BUREAU OF CHEMISTRY AND SOILS, WASHINGTON, D. C.

Emerson's Message upon the Humanization of Chemistry

Toward the end of his life Emerson gave an increasing amount of attention to education and in 1867 he was chosen an overseer of Harvard University. He gave careful consideration to proper courses of instruction and in the various lists of studies which he prepared it is interesting to observe how evenly the literary and practical studies are balanced and how the humanities, sciences and technology are each given their dues. An observation from his journal for the year 1864 deserves to be quoted in this connection:

> Language; Rhetoric; Logic; Ethics; Intellectual Philosophy; Poetry; Natural History; Civil History; Political Economy; Technology; Chemistry; Agriculture; Literary History, as the genius of Homer, Dante, Shakespeare, and Goethe; Music and Drawing, even,—all these might rightly enter in the curriculum, as well as Mathematics. But it were to hurt the University if any one of these should absorb a disproportionate share of time. (Jour. X, 38.)[1]

A better list of studies could hardly be compiled and our universities in some respects are just catching up with Emerson. The outline just quoted is only a random suggestion, for Emerson realized that such a list could be greatly extended with the inclusion of other humanities, other sciences and other arts. The studies enumerated are types and the only point which Emerson wished to bring out was that in a University all the faculties of man should receive attention.

Emerson dwelt much upon the zest and pleasure which both teacher and student should feel in all properly conducted courses of instruction. It is the natural method of youth. In his essay on "Education" he writes:

> The boy wishes to learn to skate, to coast, to catch a fish in the brook, to hit a mark with a snowball or a stone; and a boy a little older is just as well pleased to teach him these sciences. Not less delightful is the mutual pleasure of teaching and learning the secret of algebra, or of chemistry, or of good reading and good recitation of poetry or of prose, or of chosen facts in history or in biography. (Works X, 148–9.)

The same thought is expressed elsewhere in one of his journals:

> The unity in nature never invites us to indolence, but to everlasting and joyful labor. You learn as much from chemistry as from a farm or shop; that to negligence and pleasure things are dark, brutish and malignant. Chemistry, astronomy, surprise

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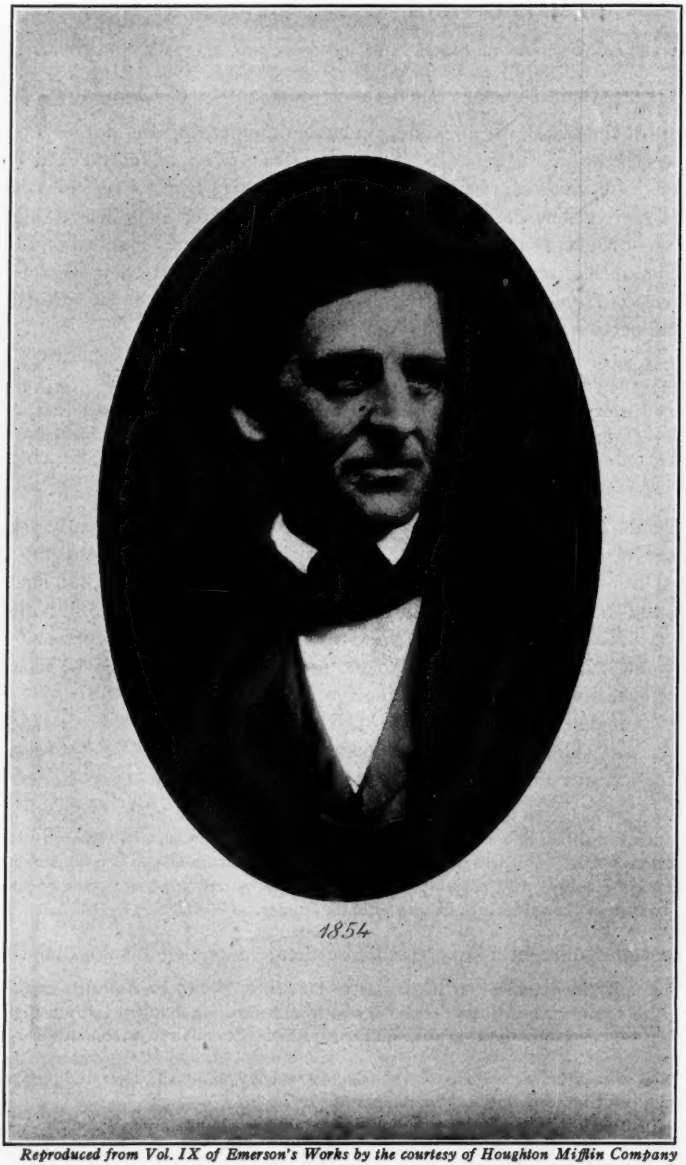
[1] The bibliographic references in this paper indicate volume and page in the Works (12 volumes) and Journals (10 volumes) of Emerson, Centenary Edition, published by Houghton Mifflin Co., Boston and New York, to whom acknowledgment is due for permission to publish the extracts which are quoted.



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RALPH WALDO EMERSON (1803–1882), FROM A DAGUERREOTYPE OF 1854

all the time, and the appointed way of man from infancy to omniscience is through an infinite series of pleasant surprises. (Jour. IV, 123.)

At a time when the extreme advocates of Greek and Latin were opposing the introduction of chemistry and other sciences into the college curriculum it is interesting to note that Emerson—a true friend of the classics if there ever was one—did not favor the old exclusive scheme of education. He believed firmly in the value of scientific studies not only to youth but to the mature man. In a delightful passage written at Naushon in 1872, when he was approaching the completion of his life work, he made the following reflection:

I thought to-day, in these rare seaside woods, that if absolute leisure were offered me, I should run to the college or scientific school which offered best lectures on Geology, Chemistry, Minerals, Botany and seek to make the alphabets of those sciences clear to me. How could leisure or labour be better employed? 'Tis never late to learn them, and every secret opened goes to authorize our aesthetics. Cato learned Greek at eighty years, but these are older bibles and oracles than Greek. (Jour. X, 393.)

Emerson, as may be inferred, was not altogether sympathetic with the methods of teaching chemistry which were practiced in his day. In one passage he exclaims:

But a chemist—what dull lectures he can contrive to make of that charming science! A chemistry is but a catalogue, as dull reading as a manual of law forms. (Jour. IV, 117–8.)

And again in his "Conduct of Life:"

Chemistry takes to pieces, but it does not construct. Alchemy, which sought to transmute one element into another, to prolong life, to arm with power,—that was in the right direction. All our science lacks a human side. (Works VI, 282.)

Emerson's solution of this difficulty, which is even more pronounced today than it was ninety-one years ago when he made the criticism, was the humanization of sciences. "Science must be studied humanly" he wrote and the second lecture of his course upon "The Philosophy of History," delivered in the winter of 1836–37, was upon "The Humanity of Science."

Emerson recommended a variety of methods for giving the sciences more of this vital and human interest. One of these was a study of the history of science. It is indicated by his statement that:

Man may be read, if you choose, in a history of the arts or in a history of sciences. (Jour. IV, 136.)

and we find this same idea expressed constantly in many pages of his works.

Another method which Emerson proposed for accomplishing this result was the indication through science of the cosmic relationships of man to the universe. It was one of the grand conceptions of the old Greek

philosophers that man was a microcosm—a duplication of the universe upon a small scale—and this conception filled the thoughts of ancient and medieval alchemists. This idea of the analogy of man to his universe, of the microcosm to the macrocosm, was one which greatly appealed to Emerson. It was crystallized in one of his favorite sayings, "The laws below are sisters of the laws above," and is indicated by many statements in his journals and essays of which only two are quoted:

We add that, as man and his planet are analogous, so the same laws which are found in these run up into the (invisible world) mind, chemistry, polarity, undulation, gravity, centrifugence, and that hereby we acquire the key to this dark, skulking, hide-and-seek, blindman's play of thoughts, namely, by the solar microscope of Analogy. 'Tis the key of the Universe. (Jour. IX, 176.)

Each material thing has its celestial side; has its translation, through humanity, into the spiritual and necessary sphere where it plays a part as indestructible as any other. And to these, their ends, all things continually ascend. The gases gather to the solid firmament: the chemic lump arrives at the plant and grows; arrives at the quadruped and walks; arrives at the man and thinks. But also the constituency determines the vote of the representative. He is not only representative but participant. Like can be known by like. The reason why he knows about them is that he is of them; he has just come out of nature or from being a part of that thing. Animated chlorine knows of chlorine, and incarnate zinc, of zinc. Their quality makes his career; and he can variously publish their virtues, because they compose him. Man, made of the dust of the world, does not forget his origin; and all that is yet inanimate will one day speak and reason. Unpublished nature will have its whole secret told. Shall we say that quartz mountains will pulverize into innumerable Werners, Von Buchs, and Beaumonts, and the laboratory of the atmosphere holds in solution I know not what Berzeliuses and Davys? (Works IV, 11–12.)

This cosmic view of the chemical origin of man was, according to Emerson, an inevitable result of the original properties of matter, and the process of creation was simply a natural development or evolution.

There is no Leap (he writes), not a shock of violence throughout nature. Man therefore must be predicted in the first chemical relation exhibited by the first atom. If we had eyes to see it, this bit of quartz would certify us of the necessity that man must exist as inevitably as the cities he has actually built. (Jour. V, 464.)

And the whole cosmos, as he beautifully shows, is characterized by a most wonderful harmony between its parts.

Science has shown the great circles in which Nature works; the manner in which marine plants balance the marine animals, as the land plants supply the oxygen which the animals consume, and the animals the carbon which plants absorb. These activities are incessant. Nature works on a method of *all for each and each for all.* The strain that is made on one point bears on every arch and foundation of the structure. There is perfect solidarity. You cannot detach an atom from its holdings, or strip off from it the electricity, gravitation, chemic affinity or the relation to light and heat and leave the atom bare. No, it brings with it its universal ties.

Nature, like a cautious testator, ties up her estate so as not to bestow it all on one generation, but has a forelooking tenderness and equal regard to the next and the next,

and the fourth and the fortieth age. There lie the inexhaustible magazines. The eternal rocks, as we call them, have held their oxygen or lime undiminished, entire, as it was. No particle of oxygen can rust or wear, but has the same energy as on the first morning. The good rocks, those patient waiters, say to him: "We have the sacred power as we received it. We have not failed of our trust, and now—when in our immense day the hour is at last struck—take the gas we have hoarded, mingle it with water, and let it be free to grow in plants and animals and obey the thought of man." (Works VII, 143–4.)

The announcements of Oersted upon magnetism were received with great satisfaction by Emerson for they seemed to confirm his ideas upon the unity of material and spiritual forces. His essay upon the "Sovereignty of Ethics" begins with the following allusion to Oersted's classical experiment:

Since the discovery of Oersted that galvanism and electricity and magnetism are only forms of one and the same force, and convertible into the other, we have continually suggested to us a larger generalization: that each of the great departments of Nature—chemistry, vegetation, the animal life—exhibits the same laws on a different plane; that the intellectual and moral worlds are analogous to the material. There is a kind of latent omniscience not only in every man, but in every particle. (Works X, 183.)

Emerson was not interested in quantitative relations and his mind, so far as this limitation went, could hardly be called scientific. It is doubtful if he ever weighed a crucible or analyzed a precipitate. The scientist can pick flaws in many of his statements and can demolish a goodly number of his analogies. But we must not criticize him upon these points unless we are ready to quarrel also with Homer or Shakespeare or St. Paul. We do not go to Emerson for facts but for optimism, sanity, tolerance of spirit, breadth of view, human sympathy, and inspiration.

Extreme specialization has almost obliterated the human interest which once attached to chemistry and other sciences so that we are far removed today from the ideals which Emerson once held. There are evidences, however, of a reaction against the modern tendency to reduce chemistry to a purely materialistic basis.

At such a time it has seemed to the writer desirable to call attention to some of the relations of America's great idealist, Ralph Waldo Emerson, to chemistry and to bring together some of the scattered opinions which he has expressed upon the humanistic values of this science. Emerson realized, perhaps better than any other writer, the dangers of an overspecialized system of education. It is hoped that the thoughts which have been here gleaned from his works and journals may prove a help and inspiration to chemists in considering some of the problems with which they are confronted.

A Selection of Some References to Chemistry from Emerson's Writings

Society exists by chemical affinity, and not otherwise. (Works VII, 14.)

There is a process in the mind very analogous to crystallization. (Jour. II, 446.)

Poetry is in Nature just as much as carbon is. (Jour. IX, 182.)

All this imperfection, as it appears to me, is a *caput mortuum*. (Jour. II, 245.)

The sublime laws play indifferently through atoms and galaxies. (Works VI, 106.)

The mixtures of spiritual chemistry refuse to be analyzed. (Works VI, 28.)

Thought is more ductile than gold, more expansive than hydrogen gas. (Jour. X, 165.)

Latent heat performs a great office in nature. Not less does *latent joy* in life. (Jour. V, 398.)

To science there is no poison; to botany no weed; to chemistry no dirt. (Works XII, 55.)

It is a chemical mixture, and not mechanical, which makes the writer. (Jour. VIII, 12.)

I wonder what is that chemical element which so differences the Englishman from the Yankee. (Jour. VIII, 417.)

What connection do the books show between the fifty or sixty chemical elements and the historical eras? (Works II, 40.)

Mind is chemical, and shows all the affinities and repulsions of chemistry and works by presence. (Jour. VII, 436.)

There is plenty of wild azote and carbon unappropriated, but it is naught till we have made it up into loaves and soup. (Jour. II, 288.)

Chemistry began by saying it would change the baser metals into gold. By not doing that it has done much greater things. (Jour. II, 288.)

The hardest chemist, the severest analyzer, scornful of all but dryest fact, is forced to keep the poetic curve of Nature. (Works VIII, 7.)

The sky, the sea, the plants, the rocks, astronomy, chemistry, keep their word. Morals and the genius of humanity will also. (Works XII, 87.)

The corn in my garden, the child of today, is a compound cord of which the sun, air, water, carbon, azote and oxygen are the plies. (Jour. IV, 77.)

The best effect of fine persons is felt after we have left their presence, as the greatest chemical energy of the prismatic spectrum is a little out of the spectrum. (Jour. V, 277.)

Memory, Imagination, Reason are only modes of the same power, as lampblack and diamond are the same chemical matter in different arrangement. (Jour. VIII, 106.)

I read somewhere that Dalton did not wait for empirical confirmation of his "law," but promulgated it, struck by its internal evidence. (Jour. VIII, 222.)

No lesson of chemistry is more impressive to me than this chemical fact that "nineteen-twentieths of the timber are drawn from the atmosphere." (Works XII, 178.)

Even the Eternal Geometer, in the fancy of Leibnitz, deduces the past and present condition of the Universe from the examination of the single atom. (Jour. I, 222.)

You will observe what sweet nitrous oxide gas all the orators appear to breathe. Once they taste it, they cling like mad to the bladder and will not let it go. (Works VIII, 386.)

Let us build altars to the Blessed Unity which holds nature and souls in perfect solution and compels every atom to serve an universal end. (Works VI, 48.)

A chemist may tell his most precious secrets to a carpenter, and he shall be never the wiser—the secrets he would not utter to a chemist for an estate. (Works II, 147.)

On the rocks of Nahant the chemical texture of the world appeared, and statistics is also a rock-of-Nahant to show that the world is a crystal and God a chemist. (Jour. VIII, 388.)

Events are not as the brute circumstance that falls, but as the life which they fall

upon. Out of the same carbon and ammonia, the rose will make a rose, and the nettle a nettle. (Jour. IX, 188.)

The sea is the chemist that dissolves the mountain and the rock, pulverizes old continents and builds new; forever redistributing the solid matter of the globe. (Works XII, 154.)

The world has a sure chemistry, by which it extracts what is excellent in its children and lets fall the infirmities and limitations of the grandest mind. (Works IV, 124.)

Every science serves an apprenticeship to some older art before it sets up for itself. Chemistry served the apothecary and physician, then the cook, manufacturer, etc., until now it is itself a science. (Jour. VII, 252.)

Quicksilver is our gauge of temperature of air and water, clay is our pyrometer, silver our photometer, feathers our electrometer, catgut our hygrometer,—but what is our meter of man, our anthropometer? (Jour. VI, 82.)

Nature shows everything once somewhere in large. Your earthquake is the first chemist, goldsmith, and brazier; he wrought to purpose in his craters, before men borrowed the hint in their crucibles. (Jour. VIII, 546; Works XII, 160.)

Chemistry is criticism on an apple and a drop of water and the glassy air, which to our fathers were wholes but which we have resolved. Is not the sublime felt in an analysis as well as in a creation? (Jour. V, 327.)

It is a small and mean thing to attempt too hardly to disprove the being of matter. I have no hostility to oxygen or hydrogen, to the sun, or the hyacinth that opened this morning its little censer in its beam. (Jour. IV, 32.)

That strikes you in hearing the discourse of a wise man, that he has brought to the crucible and analysis all that other people receive without question, as chemists are directed to select what manufacturers throw away. (Jour. II, 463.)

The invisible gas that we breathe in this room we know, if pent, has an elasticity that will lift the Appalachian Range as easily as a scrap of down; and a thought carries nations of men and ages of time on its shoulders. (Jour. VIII, 450.)

Common sense knows its own, and recognizes the fact at first sight in chemical experiment. The common sense of Franklin, Dalton, Davy and Black is the same common sense which made the arrangements which now it discovers. (Works III, 183–4, Jour. VI, 477.)

We have in no wise exhausted the books. Astronomy invites and Geology and Geometry and Chemistry. See how Humboldt and Agassiz and Berzelius and Goethe and Faraday and Brown and Lindley, work. (Jour. VIII, 57.)

The supply in nature of railroad-presidents, copper-miners, grand-junctioners, smoke-burners, fire-annihilators, etc., is limited by the same law which keeps the proportion in the supply of carbon, of alum and of hydrogen. (Works VI, 94.)

It is necessary to suppose that every hose in Nature fits every hydrant; so only is combination, chemistry, vegetation, animation, intellection possible. Without identity at base, chaos must be forever. (Works XII, 20.)

Geology itself is only chemistry with the elements of time added; and the rocks of Nahant or the dikes of the White Hills disclose that the world is a crystal, and the soil of the valleys and plains a continual decomposition and recomposition. (Works VIII, 212–3.)

I play the chemist with ashes, soap, beer, vinegar, manure, medicines; the naturalist with trees, shrubs, hens, pigs, cows, horses, fishes, bees, cankerworms, wood and coal; the politician with the selectmen, the assessors, the probate court, the town meeting. (Jour. V, 50.)

Nature encourages no looseness, pardons no errors; freezes punctually at 32°, boils punctually at 212°; crystallizes in water at one invariable angle, in diamond at

one, in granite at one; and if you omit the smallest condition, the experiment will not succeed. (Works X, 174.)

If you agree with me, or if Locke or Montesquieu agree, I may yet be wrong; but if the elm tree thinks the same thing, if running water, if burning coal, if crystals, if alkalies, in their several fashions say what I say, it must be true. (Works VIII, 13.)

One may say a gravitating solar system is already prophesied in the nature of Newton's mind. Not less does the brain of Davy or of Gay-Lussac, from childhood exploring the affinities and repulsions of particles, anticipate the laws of organization. (Works II, 37.)

I do not know if all matter will be found to be made of one element, as oxygen or hydrogen, at last, but the world of manners and actions is wrought of one stuff and begin where we will, we are pretty sure in a short space to be mumbling our ten commandments. (Works II, 240–1.)

How can we not believe in influences of climate and air, when, as true philosophers, we must believe that chemical atoms also have their spiritual cause, why they are thus and not other; that carbon, oxygen, alum, and iron, each has its origin in spiritual nature? (Works XII, 184.)

Herschel said chemistry had made such progress that it would no longer be that men would perish of famine, for sawdust could be made into food. And yet men in Sligo and Cape Verde and New York have been dying of famine ever since. (Jour. IX, 18.)

This new molecular philosophy goes to show that there are astronomical interspaces betwixt atom and atom; the world is all outside; it has no inside.

Atom from atom yawns as far
As moon from earth, as star from star. (Jour. VI, 207.)

Chemistry, Entomology, Conic Sections, Medicine, each science, each province of science, will come to satisfy all demands: the whole of poetry, of mythology, of ethics, of demonology, will be expressed by it; a new rhetoric, new methods of philosophy, perhaps new political parties, will celebrate the culmination of each one. (Jour. VI, 246.)

It is a short sight to limit our faith in laws to those of gravity, of chemistry, of botany and so forth. Those laws do not stop where our eyes lose them, but push the same geometry and chemistry up into the invisible plane of social and rational life. (Works VI, 219.)

The strangeness of the discovery is that Daguerre should have known that a picture was there when he could not see any. When the plate is taken from the camera, it appears just as when it was put there—spotless silver; it is then laid over steaming mercury and the picture comes out. (Jour. VI, 110.)

The hack is a better roadster than the Arab barb. In chemistry, the galvanic stream, slow but continuous, is equal in power to the electric spark, and is, in our arts, a better agent. So in human action, against the spasm of energy we offset the continuity of drill. (Works VI, 77.)

When Nature goes to create a national man, she puts a symmetry between the physical and intellectual powers. She moulds a large brain, and joins to it a great trunk to supply it; as if a fine alembic were fed with liquor for its distillations from broad full vats in the vaults of the laboratory. (Works X, 43.)

The lessons of science should be experimental also. The sight of a planet through a telescope is worth all the courses on astronomy; the shock of the electric spark in the elbow, outvalues all the theories; the taste of the nitrous oxide, the firing of an artificial volcano, are better than volumes of chemistry. (Works III, 258.)

There are to each function and department of Nature supplementary men; to

geology, sinewy, out-of-doors men, with a taste for mountains and rocks, a quick eye for differences and for chemical changes. Give such, first a course in chemistry, and then a geological survey. (Works VIII, 305.)

What we value, all we value, is the *naturel*, or peculiar quality of each man; and in a large, healthy individual, this is the antagonist of gravitation, vegetation, chemistry, nay, of matter itself, and so good at last as they. This is the saliency, the principle of levity, the *sal volatile*, which is the balance, or offset, to the mountains and masses. (Jour. IX, 128.)

We manage well enough with the elements, but when the elements become men, not so well; for they are no longer pure, but have such quantities of alloy as to make them of questionable use. You can extract sunbeams from cucumbers, but there is more cabbage than sunlight, and phosphate from cows, but the the chemical phosphate is better. (Jour. VII, 180.)

Nature,—what we ask of her is only words to clothe our thoughts. The mind is to find the thought. Chemistry, Geology, Hydraulics are secondary. The atomic theory is, of course, only an interior process *produced*, as the geometers say, or the outside effect of a foregone metaphysical theory; hydrostatics only the surcoat of ideal necessities. (Jour. VIII, 536.)

Precisely as the chemist submits the new substance to the action of oxygen, hydrogen, electricity, vegetable blue, etc., each soul in our little Massachusetts coterie is passed through the ordinary series of social re-agents, the market, the church, the parlour, the literary circle, writing, speaking, the ball, reforms, etc., to ascertain his distinctive powers. (Jour. V, 525.)

The world, the universe, may be reeled off from any idea like a ball of yarn. Just see how the chemist, how the Christian, how the negro, disposes of it with the greatest ease after his own peculiar habit, and finds all the facts fit and confirm his view. And each science and law is, in like manner, prospective and fruitful. (Works XII, 441–2.)

Mülder said,—For a good chemist, the first condition is, he shall know nothing of philosophy; but Oersted and Humboldt saw and said that chemistry must be the handmaid of moral science. Do you not see how Nature avenges herself of the pedantry? The wits excluded from the academies met in clubs and threw the academy into the shade. (Jour. IX, 31.)

The generalizing and ascending effort even in chemistry finds not atoms at last, but spherules of force—that makes man not a citizen or a working bee, but a sovereign end to himself; that makes minds differ as they can take strides of advance, one, another and another; onward there is always a better, a heaven, an inviting infinitude. (Jour. VIII, 480.)

The progress of manufactures finds a yellow dye in a crumbling rubbish stone; plants a thistle for its teazel; plucks a whortleberry bush for unwinding silk; saves the coke after the coal is burned, and saves the ashes after the coke is consumed; and so works up into its processes the refuse and dung of the world with the frugality of nature herself. (Jour. II, 382.)

On one side is agricultural chemistry, coolly exposing the nonsense of our spendthrift agriculture and ruinous expense of manures, and offering, by means of a teaspoonful of artificial guano, to turn a sandbank into corn; and on the other, the farmer, not only eager for the information, but with bad crops and in debt and in bankruptcy, for want of it. (Works I, 381–2.)

Geology will show that first primeval carved stone to have been a stratum precipitated and crystallized in what for aeons of uncounted time! Neither then were the particles and atoms new and raw, but mellowed and charred and decomposed from older

mixtures, when, when and where to reach their youth? A particle of azote or carbon is and remains azote and carbon, nothing can in the least wear it. (Jour. IX, 123.)

If the finders of glass, gunpowder, printing, electricity—if the healer of small pox, the contriver of the safety lamp, of the aqueduct, of the bridge, of the tunnel; if the finders of parallax, of new planets, of steam power for boat and carriage, the finder of sulphuric ether and the electric telegraph—if these men should keep their secrets, or only communicate them to each other, must not the whole race of mankind serve them as gods? (Works X, 40.)

Analysis, too, is legitimate to the poetic soul. I find analysis not less poetical than synthesis, but it must be analysis into elements and not mechanical division. If I can detect Nature converting water into hydrogen and oxygen, two beautiful and perfect wholes, I see not that it is less grand than when she recomposes water, a new whole. Mechanical analysis picks the lock; right analysis produces the key. (Jour. V, 217.)

The affinity of particles accurately translates the affinity of thoughts, and what a modern experimenter calls "the contagious influence of chemical action" is so true of mind that I have only to read the law that its application may be evident: "A body in the act of combination or decomposition enables another body, with which it may be in contact, to enter into the same state." (Works XII, 23.)

Mr. Wordsworth is a poet with the same error that wasted the genius of the alchemist and astrologers of the Middle Age. These attempted to extort by direct means the principle of life, the secret substance of matter from material things; and those to extract intelligence from remoter nature, instead of observing that science is ever approximating to truth by dint of application to present wants and not by search after general and recondite Truth. (Jour. II, 232–3.)

An idealist, if he have the sensibilities and habits of those whom I know, is very ungrateful. He craves and enjoys every chemical property, and every elemental force, loves pure air, water, light, caloric, wheat, flesh, salt, and sugar; the blood coursing in his veins, and the grasp of friendly hands; and uses the meat he eats to preach against matter as malignant, and to praise mind, which he very hollowly and treacherously serves. Beware of hypocrisy. (Jour. IX, 6.)

I do not know that I should feel threatened or insulted if a chemist should take his protoplasm or mix his hydrogen, oxygen, and carbon, and make an animalcule incontestably swimming and jumping before my eyes. I should only feel that it indicated that the day had arrived when the human race might be trusted with a new degree of power, and its immense responsibility; for these steps are not solitary or local, but only a hint of an advanced frontier supported by an advancing race behind it. (Jour. X, 348.)

Chemistry, geology, hydraulics, are secondary science. The atomic theory is only an interior process *produced*, as geometers say, or the effect of a foregone metaphysical theory. Swedenborg saw gravity to be only an external of the irresistible attractions of affection and faith. Mountains and oceans we think we understand;—yes, so long as they are contented to be such, and are safe with the geologist,—but when they are melted in Promethean alembics and come out men, and then, melted again, come out words, without any abatement, but with an exaltation of power! (Works VIII, 16.)

I cannot say accurately what is the analogon of each cosmical or chemical law; Swedenborg, or a possible Swedenborg, can; but I affirm with perfect security that such analogon for each material law observed exists in the spiritual nature, and that, better than the satisfaction in arriving at the formula of the chemic law, is the spasm (shall I say) of pleasure which pervades the intellect in recognizing, however dimly, the instant

perception of its equal holding through heaven, as well as through earth. The laws below are sisters of the laws above. (Jour. X, 206.)

These manifold tenacious qualities, this chemistry and vegetation, these metals and animals, which seem to stand there for their own sake, are means and methods only,—are words of God, and as fugitive as other words. Has the naturalist or chemist learned his craft, who has explored the gravity of atoms and the elective affinities, who has not yet discerned the deeper law whereof this is only a partial or approximate statement, namely, that like draws to like, and that the goods which belong to you gravitate to you and need not be pursued with pains and cost? (Works II, 314.)

Read chemistry a little and you will quickly see that its laws and experiments will furnish an alphabet or vocabulary for all your moral observations. Thus very few substances are found pure in nature. There are metals, like potassium and sodium, that, to be kept pure, must be kept under naphtha. Such are the decided talents which a culminating civilization produces in illuminated theatres or royal chambers. But those souls that can bear in open day the rough and tumble of the world must be of that mixed earthy and average structure, such as iron and salt, atmospheric air, and water. (Jour. IV, 133.)

How I am touched and gladly surprised by hearing the chemist propounding the theory of heat, viz., that every particle of matter is in constant revolution round its own axis, slower or faster, alike in a column of smoke or a stone jug. Increase the heat, and you accelerate the revolution by separating the atoms; increase the heat again, and the particles acquire such freedom that the form is changed to liquid; increase the heat again, and they gyrate in larger circles and become gas and (as we call it) die, or enter into the universe again. Shall we not apply the moral for our consolation to these men of fire and these men of stone that sit around us? (Jour. V, 421–2.)

The tree needs water and digging about and pruning, and protection from its enemies the slug, the louse, the borer, and so on. More than all it needs food; it will die without food; if you want fruit, you must give manure. Well, then a pretty case you make out for the Cultivator. Well, it is not gainful, and yet it seems to me much that I have brought a skilful chemist into my ground and keep him there overnight, all day, all summer, for an art that can take common water and clod, and by means of sunshine, manufacture the handsomest and most delicious Louise Bonne de Jerseys, Bartletts, Bergamots and brown berries, an inimitable manner which no confectioner can approach; and his method of working is no less beautiful than his results. (Jour. VIII, 23.)

The world wants so much alum, and so much saccharine; so much iron, and so much hemp; so much paper, and so much mahogany; nor could any rebellion or arbitrament be suffered in its atoms without chaos; if a particle of lead were to prefer to mask its properties and exert the energies of cork or of vitriol; if coal should undertake to be a lemon; or feathers, turpentine; we should have a pretty ruin, to be sure.

But the laws use azote, oxygen, carbon, lime, magnesia, and so forth, as their means; and these very excesses and defects in you, these determinations to the moral or the animal, are the very means by which high Nature works, and cannot afford to want. Be her footmen, her Fates, her couriers, muses and angels. (Jour. VIII, 311–2.)

Many readers remember that Sir Humphrey Davy said, when he was praised for his important discoveries, "My best discovery was Michael Faraday." In 1848 I had the privilege of hearing Professor Faraday deliver, in the Royal Institution in London, a lecture on what he called Diamagnetism,—by which he meant *cross-magnetism;* and he showed us various experiments on certain gases, to prove that whilst ordinarily magnetism of steel is from north to south, in other substances, gases, it acts from east to west. And further experiments led him to the theory that every chemical substance

would be found to have its own, and a different, polarity. I do not know how far his experiments and others have been pushed in this matter, but one fact is clear to me, that diamagnetism is a law of the mind, to the full extent of Faraday's idea; namely, that every mind has a new compass, a new north, a new direction of its own, differencing its genius and aim from every other mind. (Works VIII, 306.)

The chemist comes to his aid every year by following out some new hint drawn from Nature, and now affirms that this dreary space occupied by the farmer is needless; he will concentrate his kitchen garden into a box of one or two rods square, will take the roots into his laboratory; the vines and stalks and stems may go sprawling about in the fields outside, he will attend to the roots in his tub, gorge them with food that is good for them. The smaller his garden, the better he can feed it, and the larger the crop. As he nursed his Thanksgiving turkeys on bread and milk, so he will pamper his peaches and grapes on the viands they like best. If they have an appetite for potash, or salt, or iron, or ground bones, or even now and then for a dead hog, he will "indulge" them. They keep the secret well, and never tell on your table whence they draw their sunset complexion or their delicate flavors. (Works VII, 148–9.)

All the earths are burnt metals. One-half the avoirdupois of the rocks which compose the solid crust of the globe consists of oxygen. The adamant is always passing into smoke; the marble column, the brazen statue burn under the daylight and would soon decompose if their molecular structure, disturbed by the raging sunlight, were not restored by the darkness of the night. What agencies of electricity, gravity, light, affinity combine to make every plant what it is, and in a manner so quiet that the presence of these tremendous powers is not ordinarily suspected. Faraday said, "A grain of water is known to have electric relations equivalent to a very powerful flash of lightening." The ripe fruit is dropped at last without violence, but the lightning fell and the storm raged and strata were deposited and uptorn and bent back, and Chaos moved from beneath, to create and flavor the fruit on your table to-day. The winds and the rains come back a thousand and a thousand times. The coal in your grate gives out in decomposing today exactly the same amount of light and heat which was taken from the sunshine in its formation in the leaves and boughs of the antediluvian tree.

Take up a spadeful or a buck-load of loam, who can guess what it holds? But a gardener knows that it is full of peaches, full of oranges, and he drops in a few seeds by way of keys to unlock and combine its virtues; lets it lie in sun and rain, and by and by it has lifted into the air its full weight in golden fruit. (Works X, 70–1.)

First innuendos, then broad hints, then smart taps are given, suggesting that nothing stands still in Nature but death; that the creation is on wheels, in transit, always passing into something else, streaming into something higher; that matter is not what it appears—that chemistry can blow it all into gas. Faraday, the most exact of natural philosophers, taught that when we should arrive at the monads, or primordial elements (the supposed little cubes or prisms of which all matter was built up), we should not find cubes, or prisms, or atoms, at all, but spherules of force. It was whispered that the globes of the universe were precipitates of something more subtle; nay, somewhat was murmured in our ear that dwindled astronomy into a toy—that too was no finality; only provisional, a makeshift; that under chemistry was power and purpose: power and purpose ride on matter to the last atom. It was steeped in thought, did everywhere express thought; that, as great conquerors have burned their ships when once they were landed on the wished-for shore, so the noble house of Nature we inhabit has temporary uses, and we can afford to leave it one day. The ends of all are moral, and therefore the beginnings are such. Thin or solid, everything is in flight. I believe this conviction makes the charm of chemistry,—that we have the same avoirdupois matter in an alembic, without a vestige of the old form; and in animal transforma-

tion not less, as in grub and fly, in egg and bird, in embryo and man; everything undressing, and stealing away from its old into new form, and nothing fast but those invisible cords which we call laws, on which all is strung. (Works VIII, 4–5.)

A FORCIBLE METHOD OF EMPHASIZING LABORATORY TECHNIC

LAWRENCE E. STOUT, MIAMI UNIVERSITY, OXFORD, OHIO

Teachers of general chemistry are well aware of the difficulty of getting students to carry out their experiments in a workmanlike manner. Many students possessing varying degrees of interest in the work measure their attainments by the quantity of work which they can turn out, regardless of the technic displayed. Moreover, students interested in quantity production of laboratory experiments are very likely to be careless with side-shelf bottles, balances, and all factors pertaining to the general welfare of a laboratory.

Various schemes have been tried in this laboratory to stress proper technic. Fines were assessed for dirty equipment and unworkmanlike procedures, grade deductions were imposed, and even the privilege of working at extra periods was denied to careless workers.

After the admitted failure of all of these schemes to correct the existing evil, a new idea was worked out which has met marked success. It is based upon the fact that the poor technician is generally the sloppy worker. Therefore, he is the man who makes the laboratory unsightly. According to our scheme, when a student is seen performing any operation in an unworkmanlike manner he is placed on "K.P." duty for the next laboratory period. It is the duty of the "K.P." squad to scrub all side shelves, clean all reagent bottles, balance cases, and general laboratory equipment at the beginning of each laboratory period. At the close of the same period the same squad again cleans up the laboratory, puts the iron ware in its proper place and sees that all side-shelf reagents are in order.

Whereas our other schemes left little or no impression upon the offender, this menial labor performed before the whole class is as little sought after as was "K.P." duty in the army. Violators once apprehended are much more liable to do their next experiment in a workmanlike manner in order to prevent a second "K.P." assignment.

Of course, if all students carry out their experiments in a thoroughly workmanlike manner there will be no "K.P." squad available and neither will one be needed. The laboratory instructors are "urged" to watch for violators under the ruling that a disordered laboratory with no "K.P." assignments must be cleaned up by the laboratory instructor himself.

THE ELECTRON IN ORGANIC CHEMISTRY. I. THE ELECTRONIC CONCEPTION OF THE NATURE OF THE CARBON-TO-CARBON BOND FROM THE STANDPOINT OF THE THEORY OF PARTIAL POLARITY*

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Introduction

Some ninety years ago Wöhler wrote: "Organic chemistry nowadays almost drives one mad. To me it appears like a primeval tropical forest, full of the most remarkable things; a dreadful, endless jungle into which one does not dare enter, for there seems to be no way out." No doubt many a bewildered student still echoes Wöhler's sentiments. True, many intrepid explorers have, since that time, set up landmarks in the form of rules to fit more or less special cases. Yet most of these are highly empirical; hardly any two of them can be said to possess any common factual or logical basis, and nearly all of them display a distressing tendency to develop more and more exceptions as additions are made to the general store of experimental knowledge. Is there, then, no reliable compass which can guide the student through this mystifying waste in independence of the partially overgrown trails which lie on every hand?

The authors are convinced that there is. The present paper undertakes the exposition of a general theory which is offered in justification of that conviction. Future papers will deal with elaborations of the theory and with its applicability to the interpretation of various types of organic reactions. Any scientific theory may be said to have established its validity when it can be shown to explain and correlate all the phenomena to which it has been properly applied, however arbitrary may be the postulates upon which it is based. Yet the postulates here involved are not wholly arbitrary. On the contrary, their compatibility with generally accepted chemical principles endows them at the outset with a certain degree of *a priori* probability. Briefly they are these: (1) that organic radicals are possessed of varying degrees of electronegativity, and (2) that the nature of the carbon-to-carbon bond varies in accordance with the relative electronegativities of the radicals which it joins. The former concept may be most readily explained in the light of an understanding of the latter.

* *Editor's Note:* At the request of the Editor the authors have undertaken the preparation of a series of articles on the application of the electronic theory of valence to organic chemistry, with the proviso that the series will be continued if the interest of the readers of the JOURNAL seems sufficient to justify such a course. The Editor, therefore, invites comment and criticism on this and such succeeding articles as shall appear.

Earlier Representations of the Carbon-to-Carbon Bond

At the outset it will be profitable to consider briefly the means which have been employed to represent carbon-to-carbon linkages. These have been various, but we need examine only three of them, namely:

(1) The Kekulé bond	A—B
(2) The Polar bond	A+—B or A—+B
(3) The Stark-Lewis bond	A : B
	A: B
	A :B

The first great advance toward the systematization of organic chemistry was embodied in the Kekulé bond, which permitted the substitution of structural for empirical formulas. For the first time the chemist was then able to offer a reasonable explanation of the fact that two compounds entirely dissimilar in physical appearance and in chemical properties could give the same elementary analyses. Compounds could be classified into groups and group characteristics and reactions could be studied.

Yet fruitful as the Kekulé bond has been and convenient as it will remain for many ordinary purposes, it has long ago reached its limit of usefulness in the interpretation of organic reactions. By the limitations of its nature it is incapable of taking cognizance of the fact that one single bond may differ from another single bond or one double or triple bond from another double or triple bond. In ignoring this truth it implies the contrary untruth. Hence, it offers no possible ground for an explanation of the fact that, whereas the bond represented by A—B may be exceedingly stable, the bond represented by A′—B′ may be highly unstable.

The second means of representing atomic linkings, the "polar bond," has proved very useful in the inorganic field.[1] This convention has the virtue of indicating a driving force for chemical reactions, and it is legitimately applicable to all compounds in which the atoms may be considered as oppositely charged and bound by electrostatic attraction. Such a view, however, is not universally possible even in inorganic chemistry and it may be applied with propriety to only an exceedingly limited number of organic compounds. Except in the cases of the comparatively few organic compounds which ionize or hydrolyze, this means of representation necessitates certain mental reservations. Its proponents admit that it does not mean exactly what it says or, at least, that it does not always mean the same thing. They readily agree that the type of union indicated in H+—Cl is of an entirely different order from that represented by:

[1] For a full exposition of the polar theory as applied to organic reactions see H. S. Fry, *J. Am. Chem. Soc.*, **36**, 1268 (1914); *Z. phys. Chem.*, **76**, 385 (1911).

$$\begin{array}{c} Cl^- \\ + \\ Cl^- + C - H^+ \\ + \\ Cl^- \end{array}$$

Obviously, a convention which varies so greatly in meaning that it can be intelligently employed only by the initiated is of small value for the purpose of instructing the beginner. It confuses and misleads him by appearing to say what it is not intended to say.

Even in the hands of the initiated, this type of formula is open to objection, for it is incapable of indicating the fact that an atomic linking may be completely non-polar. It quite unjustifiably implies, for instance, that any carbon atom must be positive or negative with respect to another carbon atom to which it is joined. Furthermore, in common with the Kekulé bond, it fails to offer any valid explanation for the relative stability or instability of the union which it represents. Nor does it hint at any reason why triphenyl methyl chloride, for instance, should hydrolyze readily whereas methyl chloride does not hydrolyze at all.

Lewis' Electron-Sharing Concept

The theory of valence advanced by Lewis[2] points the way to a more rational and fruitful representation. It is the basis of the Lewis concept that two electrons lying between two atomic nuclei constitute the chemical bond, and that the pair of electrons may be so placed with reference to the two nuclei as to give rise to no electrical polarization, or may be displaced in the direction of one nucleus or the other to give to the one atom a negative charge and to the other a positive charge. These possibilities are indicated by Lewis in the following manner:

A : B (1) A :B (2) A: B (3)

In any case it is to be considered that the atoms A and B continue to *share* the bonding pair, and that only in the extreme case exemplified by an ionizing compound does one atom completely capture the pair at the expense of the other.

Concept of Degree of Electronegativity of Organic Radicals

This broad fundamental concept of Lewis instills new life into the philosophy of atomic bonds, but from the standpoint of the organic chemist further limitations and extensions are required to make it wholly adequate. For instance, the organic chemist well knows that, while the introduction of an ethyl group into an organic compound may produce effects quite

[2] G. N. Lewis, "Valence and the Structure of Atoms and Molecules," A. C. S. Monograph, The Chemical Catalog Co., New York, 1923.

similar to those obtained by introducing a methyl group, a phenyl group will behave differently and that the effect of a cyclohexyl group will differ from either. From the standpoint of the electronic conception of valence these differences originate in the varying degrees of attraction which the respective radicals possess for the pair of bonding electrons. This affinity or attraction for electrons we call electronegativity. Thus we arrive at the view that, not only may organic bonds be polar or non-polar, but that great variation in degree of polarity is possible.

In order to make effective use of this concept it is necessary to devise some means of determining the relative electronegativities of organic radicals. That accomplished, we would have at hand a table comparable in utility to the "electromotive series" which systematized the early chaos of inorganic chemistry.

It is obvious, since we are dealing with radicals which, for the most part, are incapable of becoming ions, that the elegantly exact quantitative method of determining inorganic electronegativities is inapplicable to our problem. Nevertheless, while a quantitative determination would be convenient and highly desirable, a relative determination would answer many practical purposes.

Method of Establishing Relative Electronegativities of Organic Radicals

In this connection the possibility of coupling two radicals of different degrees of electronegativity to the same di-valent atom and then selectively splitting off the more or less electronegative of the two suggests itself. Such a method has been perfected and has been described in detail elsewhere[3] by one of us and others. Mercury is employed as the di-valent atom.[4] When mercury is coupled with two organic radicals, R′ and R″ and the resulting compound is treated with HCl, the following reaction takes place:

$$R'HgR'' + H^+Cl^- \longrightarrow R'HgCl + R''H.$$

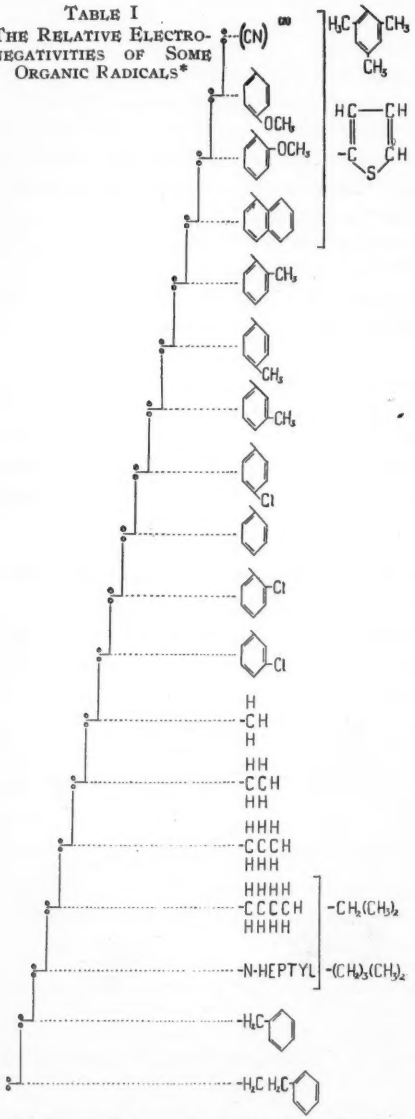
[3] Kharasch and Grafflin, *J. Am. Chem. Soc.*, **47**, 1948(1925); Kharasch and Marker, *Ibid.*, **48**, 3130 (1926); Kharasch and Flenner, Kharasch and R. Legault, unpublished work.

[4] The choice of mercury is not made at random but is dictated by experimental considerations. It is desirable to use a metal (*i. e.*, a very weakly electronegative atom) so that the organic radical may readily capture the bonding electrons and split off at ordinary temperatures under laboratory conditions.

The use of a non-metal, such as oxygen, results in a compound of the ether type which is much more difficult to disintegrate. The reasons for this difference in stability will become apparent as our discussion proceeds.

Any polyvalent metal capable of forming organo-metallic compounds would serve. Lead and tin have both been so employed. The mercury derivatives are, however, much more readily isolated and identified, and are more readily determined quantitatively.

TABLE I
THE RELATIVE ELECTRONEGATIVITIES OF SOME ORGANIC RADICALS*



* The radicals to the right of the brackets have not been precisely placed as yet. It is known that they fall within the respective ranges indicated by the bracket.

∞ From silver cyanide.

Here it is plausible to assume that the *more electronegative* of the two radicals, R′ and R″, combines with H^+ to form the corresponding hydrocarbon. Thus the relative electronegativities of the radicals R′ and R″ may be established.

By suitably varying the substituents R′ and R″, the relative order of electronegativity of a considerable number of organic radicals has been determined. These radicals are listed in Table I[5] in the order of decreasing electronegativity.

Any radical in the table will play the part of R″ in the foregoing reaction when it is coupled to mercury in company with any radical lower in the table, and the part of R′ when coupled with any radical higher in the table. If the radicals, R′ and R″, are widely separated in the table the splitting will proceed quantitatively in accordance with the given equation. If they lie very close together (as in the case of propyl and butyl, for instance) the decomposition with hydrogen chloride will give two products, but the *less negative* radical will always constitute the greater proportion of the

[5] This table is compiled from the papers already listed,[2] and from an as yet unpublished paper by one of us (Kh.) and A. L. Flenner.

R′ product. In the instance just cited six repetitions of the procedure showed the R′HgCl mixture to contain 74.2% ± 1.0% of butylmercuric chloride and 25.8% ± 1.0% of propylmercuric chloride.

Prediction of the Relative Degree of Electronegativity of Organic Radicals

In the present state of our knowledge of the physical configuration of the organic radical it is impossible to predict with mathematical exactitude just what strains may be set up or how the degree of electronegativity may be affected by substitutions in carbon chains. Nevertheless, even though such predictions may occasionally fail, *once the relative electronegativities of two radicals are experimentally determined, it is possible to predict with precision the nature and degree of stability of the bond which will be formed by their union.*

In the case of a *single* carbon atom, we are able to state the effect of the attachment of groups.[6] For a comparatively electronegative substituent such as the phenyl radical the effect is as indicated in Figure 1. Thus we know that a triphenyl methyl group or a carboxyl group is far less electronegative than any of those listed in Table I. If we replace the hydrogen atoms of the methyl group by radicals more electronegative than phenyl, the radical X_3C (where X represents a group more electronegative than phenyl) should be less electronegative than triphenyl methyl, thus:

$(C_6H_5)_3$ C .....:

X_3C .....└——:

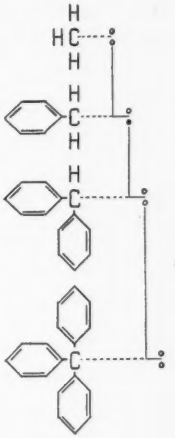


FIGURE 1

At a more advanced point in our discussion we shall again refer to this paragraph in advancing an interpretation of the phenomenon of "free radicals."

Extension of the Lewis Concept

With these facts in mind it is possible to return to the consideration of the Lewis concept. It is now evident (as has been pointed out by one of of us and Sher[7]) that from the standpoint of the organic chemist, numerous variations of the types of union indicated by Lewis are possible. These possibilities may be expressed most conveniently in terms of the Bohr concept of electronic energy levels. The adoption of this terminology does not commit us to any specific mechanical theory of the structure of the atom. If there existed a detailed and commonly acceptable mechanical model of the carbon atom, it would be possible to translate our theory

[6] See Kharasch and Marker, *loc. cit.*

[7] Kharasch and Sher, *J. Phys. Chem.*, **29**, 625 (1925).

into terms of that model, but it would still be more convenient for all practical purposes to employ a more general and more schematic representation. Therefore, in directing the attention of the reader to Figure 2, we particularly desire to emphasize the fact that *no portrayal of actual electronic paths is attempted.* For that reason we shall avoid the use of the term "orbit" and confine ourselves to a discussion of energy levels. Furthermore, it should be understood that the figure indicates only a sufficient number of energy levels to illustrate conveniently the concept we desire to advance. We hold that the number of possible energy levels in the Bohr sense is finite but we do not attempt to designate that number.

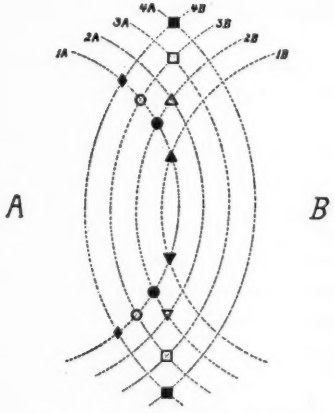


FIG. 2.—SCHEMATIC REPRESENTATION OF THE BOND BETWEEN TWO CARBON ATOMS AND SOME POSSIBLE VARIATIONS THEREOF

In terms of Figure 2, then, the arcs numbered 1_A, 2_A, 3_A, 4_A and 1_B, 2_B, 3_B, 4_B represent some of the possible energy levels which electron pairs may occupy in the carbon atoms A and B, respectively. The pairs of dots, squares, triangles, etc., represent electron pairs shared in various possible manners which entail varying degrees of polarity and stability in the bonds thus constituted.

Here it should be noted that polarity and stability are only indirectly related. From our standpoint, the rather widespread impression that non-polarity in a bond necessarily indicates a high degree of stability is incorrect. Strictly non-polar bonds display a wide range of stabilities. A detailed consideration of the figure will make this point clear.

To be more specific, the pair of black triangles represents a pair of valence electrons shared in the first energy levels of atoms A and B. The bond thus constituted is non-polar and highly stable. It is typical of compounds like diphenyl or dinaphthyl, where the two radicals joined are highly and equally electronegative.

The white triangles designate an electron pair shared in the second energy levels of atoms A and B and likewise constitute a strictly non-polar bond. This bond, however, is somewhat less stable than the one first discussed. It is exemplified in the linkage of two moderately and equally electronegative radicals. Ethane, which can be considered as composed of two methyl groups, may be cited in illustration.

The white and the black squares represent electrons held in the third

and fourth energy levels, respectively. These bonds are also non-polar and represent successively decreasing degrees of stability. The latter may be considered as illustrating the union between radicals of very slight electronegativity (such as triphenyl methyl) and is of such low stability that it may be readily ruptured to give rise to "free radicals."

These illustrations demonstrate that *the primary criterion of the stability of a carbon-to-carbon bond is not its polarity or non-polarity but the affinity of the bound radicals for the binding electrons.* When the electrons are strongly (closely) held by both carbon nuclei the bond is stable; when they are weakly held (*i. e.*, when they are displaced away from) one or both nuclei the bond is unstable. The relative stability is a direct function of the closeness with which the electrons are held by the radicals in question.

Upon this basis the facts cited in Professor Gomberg's article on "Organic Radicals"[8] are readily explainable. We recall to the reader's attention the observations set forth, in connection with Figure 1, on the effect of substitution in the methyl radical. In connection with those remarks we take the liberty of quoting at some length from a previous paper by one of us and Marker.[9]

> Reference to the tables in the article mentioned[8] will disclose the fact that radicals which in the Table of Electronegativity lie above the phenyl radical increase dissociation, while those below the phenyl radical hinder or stop it completely. It is also instructive to note that since the diphenyl radical is more electronegative than the phenyl radical, it increases the dissociation of the hexa-aryl ethane much more than the phenyl radical. The fact also that the α-naphthyl radical is more electronegative than the β-naphthyl radical causes it to be more potent in causing dissociation of the hexa-aryl ethane molecule.
>
> These considerations we hope will help to clarify the confusion relative to influences causing dissociation in the hexa-aryl ethane series. Thus Gomberg writes, "From Schlenk's results with diphenyl-hexa-aryl ethanes one might infer that the dissociation of the hexa-aryl ethane into free radicals is greatly favored by the complexity or the weight of the aryl groups, the dissociation becoming apparently more manifest also in proportion to the number of such groups. Some support in favor of this inference is given by the α-naphthyl-diphenylmethyl, which was found to be monomolecular to the extent of 60%. But the hypothesis that the dissociation of the hexa-aryl ethane is proportional to the complexity of the aryl groups becomes wholly untenable when one compares triphenylmethyl with phenylxanthyl, $C_6H_5.C{=}(C_6H_3)_2{=}O$, which is monomolecular to the extent of 75%. Is the union of two phenyl groups the paramount influence in this case? . . . . More facts are needed before we can hope to clarify this confusing interplay of various influences."
>
> According to our hypothesis the weight or complexity of the radical is of no signficance in this case and no logical deductions can be made from it; it is the electronegativity of the radical attached to the methyl carbon atom (with the consequent decrease in the electronegativity of the methyl group) that is of paramount importance.

[8] M. Gomberg, *Chem. Rev.*, **I**, 104 (1924).

[9] Kharasch and Marker, *loc. cit.*

That is the reason the cyclohexyl radical decreases dissociation of the aryl ethane while the naphthyl radical increases it, although both of them are heavier than the phenyl radical, and the reason the α-naphthyl increases dissociation more than the β-naphthyl radical, for the former is the more negative radical.

Returning to a further consideration of Figure 2, it will be seen that varying degrees of polarity in atomic linkings are possible. In order to offer illustrations covering a wide range of polarity it will be convenient to consider that A represents a radical capable of extreme electronegativity (such as the chloride), and that B represents an organic radical. With that understanding we may say that the black circles represent an electron pair shared by a chloride radical and a highly electronegative organic radical, such as phenyl or naphthyl. The white circles represent an electron pair shared by a chloride and a moderately electronegative organic radical, such as methyl. The diamonds represent a bonding pair of electrons shared by a chloride and a weakly electronegative organic radical—such as triphenyl methyl. These bonds increase in degree of polarity in the order named.

If ease of hydrolysis may be considered as evidence of instability it will be noted that these bonds decrease in stability as the degree of polarity increases. Thus phenyl chloride is exceptionally difficult to hydrolyze; methyl chloride may be hydrolyzed by boiling with alcoholic KOH; while triphenyl methyl chloride is hydrolyzed to some extent by water in the cold and very rapidly by hot water. Yet this coincidental relationship between polarity and stability does not in any way conflict with what we have already said concerning the fundamental cause of stability. From our standpoint these bonds decrease in stability in the order named for the reason that the radicals joined to the chloride decrease in the order named in the ability to hold closely to the electron pair. *A low degree of affinity for electrons (i. e., of electronegativity) on the part of a radical results in instability of the bond which that radical may form with another radical or atom, regardless of the polarity of the bond thus formed.*

Correlation of the Electronic Structures of Organic Molecules with Their Energy Contents. (Heats of Combustion)

We have described our conception of the carbon-to-carbon bond in terms of energy levels occupied by the bonding electron pair. The employment of this terminology immediately suggests to the thermodynamically minded that energy should be absorbed or released whenever a bond is altered in a manner entailing a shift of the electron pair from one level to another. If it were possible to choose a state of reference and, by means of quantitative reactions, to bring a number of different bonds to this reference state, at the same time measuring the energy change involved, an interesting test of the validity of the theory could be made. The

necessary conditions of the test suggested are fulfilled by the measurement of heats of combustion. In this case the disposition of the electrons which prevails in CO_2 constitutes the reference state, and combustion the quantitative reaction which may be employed to reach it.

A detailed discussion of this manner of considering heats of combustion is to be found in a paper by one of us and Sher[10] and will be extended in future papers. Briefly recapitulated, the postulates involved are:

(1) Heat of combustion is due to the liberation of energy in the interdisplacement or shift of electrons between atoms or radicals. It should thus be possible to correlate, at least empirically, the heat of combustion with the total number of electrons displaced.

(2) The heat of combustion is a function of the total number of electrons displaced, and must be an integral multiple of the heat value of one electron.

(3) The net amount of energy in the form of heat liberated by the interdisplacement of electrons from an arrangement such as exists in a methane type of molecule to that of the carbon dioxide type is approximately 26.05 kg. cal. per mol per electron. (This figure is derived empirically from a consideration of the experimental data.)

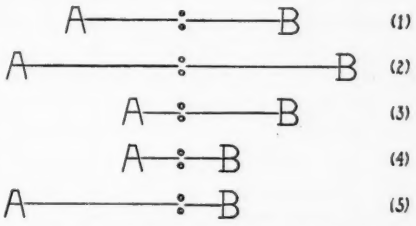


FIG. 3—TYPES OF BONDS IN ORGANIC MOLECULES

(1) Type of bond characteristic of aliphatic hydrocarbon, with ethane as a representative compound; (2) a bond in which both groups joined are weakly electronegative as in the case of the two carboxyls forming oxalic acid, or two triphenylmethyl nuclei; (3) a bond between a moderately electronegative radical (such as methyl) and a strongly electronegative radical like phenyl or naphthyl; (4) a bond between two highly electronegative radicals, such as phenyl or naphthyl; (5) a bond between a highly electronegative radical (such as phenyl or naphthyl) and a very weakly electronegative radical (such as carboxyl). Type 5 may be considered as a special case of type 3.

(4) Electrons constituting bonds of greater or lesser energy content than the ethane bond will liberate more or less heat, respectively, upon oxidation of the carbon atoms to CO_2. [See Fig. 3, bonds (2), (3), (4), and (5)].

(5) The pair of electrons held together by two carbon atoms in saturated hydrocarbons may be considered intermediate between their respective normal energy levels and the level which the electrons occupy in carbon dioxide. The net energy which they supply upon combustion is thus the same as if we had a pair of electrons in the valence shell of one carbon atom of the methane type. This rather plausible assumption is well justified by the agreement between calculated and observed values.

The significance of these postulates is most readily grasped in the light of Figure 3. This figure does not differ in any essential from Figure 2

[10] Kharasch and Sher, *loc. cit.*

but will be found somewhat more convenient for application to the matter under discussion.

It may be considered that the quantity of heat liberated in the combustion of ethane is expressible by means of two terms of opposite sign. The positive and the larger of these terms, which we may call Z, represents the work done *by* the electrons in moving into an inner energy level of the oxygen atom.

The smaller and negative term, which we may call Y, represents the work which must be done *on* the electrons in displacing them away from the carbon nucleus. The observed heat of combustion may be called X which is equal to $Z - Y$. It is evident, therefore, that if the electrons are already displaced somewhat farther from the carbon atoms than they are in the case of ethane [*cf.* bond of type (2), Fig. 3], the quantity Y becomes smaller in value, whereas Z remains constant. The net observed heat, X, then becomes larger. The reverse is true in the case of bonds of types (3) and (4).

Since Z is always constant, it is possible to eliminate that term from our calculations and to write our formula in terms of variations from the X measured when ethane compounds are combusted. Hence, if Q is taken as the mol heat of combustion in kilogram calories, 26.05 as the number of kilogram calories liberated in the shifting of one electron from an ethane to a CO_2 bond, and N as the number of electrons so shifted, we may write for the four types of bond illustrated:

(1) $Q = 26.05 \times N$ kg. cal.
(2) $Q = 26.05 \times N + a$ kg. cal.
(3) $Q = 26.05 \times N - b$ kg. cal.
(4) $Q = 26.05 \times N - c$ kg. cal.

Here, b and c have the following numerical values:

$b = 3.5$ kg. cal.
$c = 6.5$ kg. cal.

No value is assigned to a, for only one determination on this type of bond is to be found in the literature. The heat evolved in the combustion of one mol of triphenyl methyl is reported by Schmidlin[11] to be 2381.0 kilogram calories, which is, as predicted, larger than 2370.4, the value calculated by the use of formula (1).

On the basis of a strict application of our theory it would be expected that no formula could be applied exactly to more than one combination of radicals. The members of the ethane series, for instance, should vary the constant by a minute increment as one proceeds through the series. No doubt they do, but the increment is so slight as to be utterly incomparable to the normal experimental error. If methods of determination are

[11] Schmidlin, *Ann. chim. phys.* [8] **7**, 195 (1906).

ever sufficiently refined it will be possible to produce a more refined and rigorously exact series of formulas.

The following tables compare a number of observed heats of combustion compiled from the literature for the "International Critical Tables" with the values calculated by the use of our formulas. Table II refers only to compounds of type (1) (saturated aliphatic hydrocarbons); Table III to compounds of type (3) (unions of moderately with strongly electro-

TABLE II

COMPOUNDS OF TYPE 1

(Saturated Aliphatic Hydrocarbons)

$Q = 26.05 \times N$

Formula	Name	N	Kg. cal. Calculated[a]	Kg. cal. Observed	Literature reference†
CH_4	Methane (g)	8	208.4	210.8	12
C_2H_6	Ethane (g)	14	364.7	368.4	12
C_3H_8	Propane (g)	20	521.0	526.3	12
C_4H_{10}	Isobutane (g) (Trimethyl methane)	26	677.3	683.4	12
C_5H_{12}	*n*-Pentane (g)	32	833.6	838.3	13
C_5H_{12}	*n*-Pentane	32	833.6	833.4	13
C_5H_{12}	Isopentane (g)	32	833.6	843.5	13
C_5H_{12}	Isopentane	32	833.6	838.3	13
C_5H_{12}	Tetramethyl methane (g)	32	833.6	842.6	12
C_6H_{14}	*n*-Hexane	38	989.9	991.4	14
				989.8	15
C_6H_{14}	Di-isopropyl (g)	38	989.9	993.9	12
C_7H_{16}	*n*-Heptane	44	1146.2	1137.3	16
				1149.9	17
C_7H_{16}	*2*-Methylhexane	44	1146.2	1148.9	17
C_7H_{16}	*3*-Methylhexane	44	1146.2	1148.9	17
C_7H_{16}	*2,2*-Dimethylpentane	44	1146.2	1148.9	17
C_7H_{16}	*2,3*-Dimethylpentane	44	1146.2	1148.9	17
C_7H_{16}	*3,3*-Dimethylpentane	44	1146.2	1147.9	17
C_7H_{16}	*2,4*-Dimethylpentane	44	1146.2	1148.9	17
C_7H_{16}	*3*-Ethylpentane	44	1146.2	1149.9	17
C_7H_{16}	*2,2,3*-Trimethylbutane	44	1146.2	1147.9	17
C_8H_{18}	*n*-Octane	50	1302.5	1302.7	15
				1304.7	18
				1305.2	19
C_8H_{18}	*2,5*-Dimethylhexane	50	1302.5	1303.3	18
C_8H_{18}	*2*-Methylheptane	50	1302.5	1306.1	18
C_8H_{18}	*3,4*-Dimethylhexane	50	1302.5	1303.7	18
C_8H_{18}	*3*-Ethylhexane	50	1302.5	1302.3	18
C_8H_{18}	*2,2,4*-Trimethylpentane	50	1302.5	1303.9	17
C_8H_{18}	Hexamethylethane (s)	50	1302.5	1301.8	17
$C_{10}H_{22}$	Decane	62	1615.1	1610.2	15
$C_{10}H_{22}$	Di-isoamyl	62	1615.1	1615.8	20
$C_{16}H_{34}$	Hexadecane (s)	98	2552.9	2559.1	21
$C_{20}H_{42}$	Eicosane (s)	122	3178.1	3183.1	21

[a] See Ref. *a* under Table III. † See pp. 416–7.

TABLE III

COMPOUNDS OF TYPE 3

$Q = 26.05 \times N - 3.56b$

Formula	Name	N	Kg. cal. Calculated[a]	Kg. cal. Observed	Literature reference
C_6H_6	Benzene (g)	30	781.5	786.2	22
C_6H_6	Benzene	30	781.5	783.4	20
				782.3	23
C_7H_8	Toluene	36	934.3	937.0	24
				934.2	23
C_8H_{10}	*o*-Xylene	42	1087.1	1094.2	24
				1091.7	18
C_8H_{10}	*m*-Xylene	42	1087.7	1091.7	24
				1088.4	23
C_8H_{10}	*p*-Xylene	42	1087.1	1089.1	18
C_8H_{10}	Ethylbenzene	42	1087.1	1091.2	24
C_9H_{12}	Mesitylene	48	1239.9	1243.6	24
C_9H_{12}	*n*-Propylbenzene	48	1246.9	1246.4	24
C_9H_{12}	Isopropylbenzene	48	1246.9	1247.3	24
C_9H_{12}	Pseudocumene (*1,2,4*-Trimethyl-benzene)	48	1239.9	1241.7	24
$C_{10}H_{14}$	*tert.*-Butylbenzene	54	1403.2	1400.4	24
$C_{10}H_{14}$	*1,2,4,5*-Tetramethylbenzene (s) (Durol)	54	1392.7	1393.6	25
$C_{10}H_{14}$	Isopropyltoluene (1,4) (Cymene)	54	1399.7	1412.3	26
				1402.8	27
$C_{10}H_{14}$	*n*-Propyltoluene (1,3)	54	1399.7	1405.4	28
$C_{10}H_{14}$	Isopropyltoluene (1,3)	54	1399.7	1409.5	28
$C_{11}H_{16}$	Pentamethylbenzene (s)	60	1545.5	1554.0	25
$C_{12}H_{18}$	Hexamethylbenzene (s)	66	1700.3	1711.9	25
$C_{13}H_{12}$	Diphenylmethane (s)	64	1660.2	1655.0	26
$C_{14}H_{14}$	Dibenzyl (s)	70	1816.5	1810.6	26
$C_{19}H_{16}$	Triphenylmethane (s)	92	2386.1	2379.3	26
				2388.7	11
$C_{25}H_{20}$	Tetraphenylmethane (s)	120	3112.0	3102.4	11

[a] It should be noted that all of these calculations are based upon the combustion of liquid compounds. For compounds in the gaseous state the heat of vaporization should be subtracted from the observed heat of combustion before comparison is made with the calculated value. Likewise, for compounds in the solid state, the heat of fusion should be added to the observed value.

Theoretically speaking, other factors enter in. For instance, the difference between the specific heats of a compound in the liquid and the gaseous state or in the solid or supercooled liquid state affect the observed value also. These sources of error, however, are small compared with the experimental error and may be neglected here.

[12] Thomsen, "Thermochem. Unters. IV: letzte Zusammenstellung," *Z. phys. Chem.* **52,** 343 (1905).

[13] Roth and Macheleldt, Diss. Braunschweig (1921), quoted in Landolt-Börnstein Tabellen (1923).

[14] Stohmann and Kleber, *J. prakt. Chem.* [2] **43,** 1 (1891).

[15] Swietoslawski, *J. Am. Chem. Soc.* **42,** 1092 (1920).

[16] Louginine, *Compt. rend.* **93,** 274 (1881).

TABLE IV
COMPOUNDS OF TYPE 4
$Q = 26.05 \times N - 6.5c$

Formula	Name	N	Kg. cal. Calculated[a]	Kg. cal. Observed	Literature reference
$C_{10}H_8$	Naphthalene (s)	48	1233.4	1232.5	29
				1231.9	30
				1229.9	31
$C_{12}H_{10}$	Diphenyl (s)	58	1497.9	1493.6	25
$C_{12}H_{10}$	Acenaphthene (s) (Peri-ethylene naphthylene)	58	1490.0	1491.3	26
$C_{13}H_{10}$	Fluorene (s)	62	1595.1	1584.9	19
$C_{14}H_{10}$	Anthracene (s)	66	1705.3	1693.4	25
				1700.4	32
				1691.6	33
$C_{14}H_{10}$	Phenanthrene (s)	66	1693.3	1692.5	25
$C_{18}H_{18}$	Retene (s) (Methyl isopropylphenanthrene)	90	2311.5	2306.8	26
$C_{18}H_{16}$	Chrysene (s)	84	2159.2	2139.1	26
$C_{24}H_{18}$	*1,3,5*-Triphenylbenzene (s)	114	2940.2	2936.7	26

negative radicals); and Table IV to compounds of type (4) (unions of strongly electronegative radicals).

Summary

We may sum up the foregoing exposition by saying that earlier conceptions of the carbon-to-carbon bond are inadequate to represent truthfully the nature of organic compounds or to interpret organic reactions. The conception advanced by us surmounts many of the limitations of its predecessors. Briefly, it involves the following postulates: (1) The bond consists of a pair of electrons shared by two atomic nuclei. (2) Atomic nuclei

[17] Bureau of Standards, unpublished work.

[18] Richards and Jesse, *J. Am. Chem. Soc.* **32,** 268 (1910).

[19] Roth, unpublished work. Authority for this value in Landolt-Börnstein Tabellen (1923).

[20] Richards and Davis, *J. Am. Chem. Soc.*, **42,** 1599 (1920); **39,** 341 (1917).

[21] Stohmann, Kleber, Langbein, and Offenhauer, *J. prakt. Chem.* [2] **49,** 99 (1894).

[22] Stohmann, Rodatz and Herzberg, *Ibid.* [2] **33,** 241 (1886).

[23] Roth and v. Auwers, *Lieb. Ann.*, **407,** 145 (1915).

[24] Richards and Barry, *J. Am. Chem. Soc.*, **37,** 993 (1915).

[25] Stohmann, Kleber, and Langbein, *J. prakt. Chem.* [2] **40,** 77 (1889).

[26] Stohmann, *Z. phys. Chem.*, **6,** 334 (1890).

[27] Stohmann, Rodatz, and Herzberg, *J. prakt. Chem.* [2] **35,** 22 (1887).

[28] Genvresse, *Bull. soc. chim.* [3] **9,** 219 (1893).

[29] Henning, *Z. phys. Chem.*, **97,** 467 (1921).

[30] Bureau of Standards, Circ. 11, 3rd ed., 191F.

[31] Swietoslawski and Starczewska, *Bull. soc. chim.* [4] **31,** 654 (1922).

[32] Weigert, *Z. phys. Chem.*, **63,** 458 (1908).

[33] Swietoslawski, Private communication.

are capable of varying degrees of affinity or attraction for the electron pair. This property we have called electronegativity. Strictly speaking, there are no electropositive radicals. All radicals are electronegative to a greater or lesser degree; *i. e.*, all have more or less attraction for the electron pair. (3) The stability of the bond is a function of the electronegativities of the radicals which it joins; *i. e.*, of the tenacity with which the electron pair is held by the nuclei. (4) Bonds may be totally non-polar or may display a wide range of polarities. Polarity and stability are only indirectly and coincidentally related. Non-polar bonds display a wide range of stabilities (as, also, do polar bonds).

A method of determining the relative degrees of electronegativity of organic radicals has been described and a table of electronegativities determined has been given. The rule governing the effect of substitutions upon the electronegativity of the methyl radical has been given. The existence of free radicals has been explained and the causes which give rise to them have been stated. A means of correlating molecular structure with heat of combustion has been advanced and tables compiled from the literature are offered for the comparison of calculated with observed values.

In the next article of the projected series, the authors plan to extend the electronic theory somewhat and to discuss, from that point of view, the nature of the double bond, the Thiele hypothesis (1, 4 addition), the rules governing addition at double bonds, and some of the reactions of unsaturated compounds. Later articles will deal with other types of organic compounds and reactions.

The authors are aware that the attempt to confine the exposition of such a theory within reasonable space limitations may occasionally lead to the omission of details or amplifications necessary to complete clarity. The authors will be glad to extend the discussion of points which readers find confusing or open to objection, either by personal communication or through the Correspondence columns of the JOURNAL.

Romans Welded Iron 1800 Years Ago. Roman artisans in England only two to three centuries after the time of Christ knew how to weld iron and how to join or "solder" two pieces of iron together with copper, the Institute of Metals was told, at its meeting, by Profs. J. Newton Friend and W. E. Thorneycroft of the Technical College, Birmingham. The specimen examined by them was a deep iron ferrule, like a modern napkin ring, that was unearthed during excavations of the Roman city of Uriconium located on the river Severn and destroyed about A.D. 380.

Lead pipe manufactured and laid in Rome's water system 1800 years ago was pronounced to be in perfect condition by William A. Cowan, chemist of the National Lead Company, Brooklyn, N. Y., in a communication to the Institute. Analysis showed that the same lead was used by the Romans in England and Italy.—*Science Service*

MERCURY AND ITS COMPOUNDS IN ANCIENT TIMES*

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The peculiar and striking properties possessed by metallic mercury exercised a special influence on the beginnings of chemical thought. This element captivated the imaginations of the ancients and played a major rôle in the fantastic doctrines of the alchemical art. The date of the first knowledge of mercury can be set back considerably farther than most historians of chemistry have generally believed. The earliest find of the metal itself was made by Schliemann during his Egyptian travels to Kurna.[1] This archaeologist unearthed a small flask of the metal, along with other objects of technical interest, in a tomb dating back to 1500–1600 B.C. This is the sole evidence of the knowledge of the metal among the ancients until we come to the Greeks. Other facts, such as the probable antiquity of some of the recipes of the Leyden Papyrus employing mercury, tend to show that the metal was known in Egypt at this early date.

The earliest written evidence of a definite date concerning mercury is given by Aristotle who refers to it as a "fluid silver."[2] A method of obtaining mercury from the native sulfide is given by Theophrastus, who states,[3]

> Such is the production of quicksilver, which has its uses. This is obtained from cinnabar rubbed with vinegar in a brass mortar with a brass pestle.

This passage is also the first evidence of the process of amalgamation.

Dioscorides, writing at about the beginning of our era, describes the recovery of mercury by distillation. This primitive method and rudimentary distilling arrangement is about the earliest reference to this important chemical operation. The account reads thus:[4]

> Quicksilver is made from "ammion," which is called cinnabar. An iron bowl containing cinnabar is put in an earthen vessel and covered with a cup-shaped lid smeared with clay. Then it is set on a fire of coals and the soot which sticks to the cover, when wiped off and cooled, is mercury.

The same author also refers to native mercury in the same passage:

> Quicksilver is also found in drops falling from walls of silver mines. Some say there are quicksilver mines.

Among the Latin writers, Vitruvius and Pliny both give interesting references to this metal. Evidently the Romans made a distinction between native mercury and that prepared artificially from cinnabar, for the for-

* Paper read before the Division of History of Chemistry at the 74th Meeting of the American Chemical Society at Detroit, Mich., September 8, 1927.

[1] von Lippmann, "Entstehung und Ausbreitung der Alchemie," p. 601.

[2] Meteorlogica IV, 8, 11.

[3] "On Stones" (from p. 139 of Hill's translation).

[4] Materia Medica V, 70.

mer was termed "argentum vivum" or quicksilver, while the latter was called "hydrargyrum" meaning, literally, silver water. Thus in this case they made a distinction between substances chemically identical, whereas in so many other cases they classed chemically different substances under the same name, all as a result of their unscientific classification of the various forms of matter.

Vitruvius gives us some valuable information as regards the early knowledge of mercury. This author describes the recovery of mercury from the ore, both in the native state and by a crude method of smelting, in the following passage:[5]

> Minium is an ore. During the digging it sheds tears of quicksilver which the miners collect and save. The masses of ore as they are taken from the mines are so full of moisture that they are thrown into a furnace or oven in the workshop to dry, and the fumes that are driven off from them by the heat of the fire, settle down on the floor of the oven and are found to be quicksilver. When the lumps of ore are taken out, the drops which remain are so small that they cannot be gathered up, but they are swept into a vessel of water, and there they run together and combine into one.

Vitruvius also records some interesting observations on the density of mercury, stating:[6]

> If quicksilver be placed in a vessel and a stone of a hundred pounds weight be placed on it, it will swim at the top, and notwithstanding its weight, be incapable of pressing the liquid so as to break or separate it. If this be taken out, and only a scruple of gold be put in, that will not swim, but will immediately descend to the bottom. This is a proof that the quantity of body does not depend upon its weight but upon its nature.

Certainly this is an experiment in physics undertaken with the true scientific attitude. The distinction between mass and weight is clearly stated here for the first time as far as our existing records show. Vitruvius is also the first one to mention the fact that mercury unites with gold, and the first author to mention the employment of mercury for recovering gold. His statement on amalgamation is this:[7]

> Quicksilver is used for many purposes; without it neither silver nor brass can be properly gilt. When gold is embroidered on a garment which is worn out and no longer fit for use, the cloth is burnt over a fire in earthen pots; the ashes are thrown into water and quicksilver added to them; this collects all the particles of gold and unites with them. The water is then poured off and the residuum placed in a cloth, which when squeezed with the hand, suffers the liquid quicksilver to pass through the pores of the cloth, but retains the gold in a mass within it.

It is rather probable that amalgamation with gold was discovered earlier than this date (1st century B.C.) but this account of Vitruvius, just quoted, is the earliest known reference to the process.

[5] De Architectura, VII, 8.
[6] *Ibid.*, VII, 8.
[7] *Ibid.*, VII, 8.

Pliny's statements on mercury and cinnabar are clear and free from ambiguity. Concerning native quicksilver and its properties, he writes:[8]

> There is a mineral found in these veins of silver, which yields a humor that is always liquid, and is known as quicksilver. It acts as a poison upon everything, and pierces vessels even, making its way through them by the agency of its malignant properties. All substances float upon the surface of quicksilver, with the exception of gold, this being the only substance it attracts to itself. Hence it is, that it is such an excellent refiner of gold; for on being briskly shaken in an earthen vessel with gold, it rejects all the impurities that are mixed with it. When once it has expelled these superfluities, there is nothing to do but to separate it from the gold; to effect which it is poured upon skins which have been well tawed, and so exuding through them like a sort of perspiration, it leaves the gold in a state of purity behind.

It is evident that amalgamation was a well-recognized phenomenon in Pliny's time. The last passage is one of our earliest references to filtration as a means of separating substances. In another passage Pliny gives the method of preparing mercury from the ore. It will be remembered that the Romans considered the metal obtained in this way as being different from native mercury or even inferior to it, and gave it another name. The methods of obtaining mercury from cinnabar in ancient times were, according to Pliny, these:[9]

> Human industry has also discovered a method of extracting hydrargyros from the inferior minium, a substitute for quicksilver, the further mention of which was deferred, a few pages before, to the present occasion. There are two methods of preparing this substance: either by pounding minium and vinegar with a brazen pestle and mortar, or else by putting minium into flat earthen pans, covered with a lid, and then enclosing it in an iron seething pot well luted with potter's clay. A fire is then lighted under the pans, and the flame kept continuously burning by the aid of the bellows; which done, the steam is carefully removed, that is found adhering to the lid, being like silver in color, and similar in its fluidity. The liquid, too, is easily made to separate in globules, which, from their fluid nature, readily unite.

Apparently the chief use of mercury in Grecian and Roman times was in gilding. There is no evidence showing that amalgamation was applied to obtain gold from its ores as early as this period, although this may have been done on a small scale, since gold was so recovered from garments embroidered with the metal.

Among the recipes of the Leyden Papyrus X are a number that employ mercury as an ingredient. There can be no doubt, from the evidence in this document, that the Ancients were acquainted with a considerable number and variety of mercury amalgams, both simple and complex. It has been seen that the fact that gold would unite with mercury was

[8] Natural History, Bk. XXXIII, chap. 32.
[9] *Ibid.*, Bk. XXXIII, chap. 41.

known in the time of Vitruvius. Several of the recipes in this manuscript give preparations of gold amalgam. This is typical:[10]

No. 54—Preparation of Gold Liquid—Place the leaves of gold in a mortar, pulverize them with mercury and it is done.

There are no recipes in this document that give the preparation of silver amalgam, and as far as the evidence shows, this amalgam does not seem to have been prepared in ancient times. The fact that copper would unite with mercury was well known. A process in which this knowledge was applied to use is the following:

No. 54—Coating of Copper—If you desire that copper shall have the color of silver; after having purified the copper with care, place it in mercury and white lead; mercury alone suffices for coating it.

Tin amalgam was also a well-known product. The recipe quoted here was a preparation intended to give copper objects a silvery appearance and is clearly a simple tin amalgam. The text reads:

No. 27—Coloring in Silver—For silvering objects of copper; tin in sticks, 2 drachmas; mercury, 2 drachmas; earth of Chios, 2 drachmas. Melt the tin, throw on the crushed earth, then the mercury, and stir with an iron and fashion into globules.

There are also several recipes in this papyrus in which mercury was combined with two or more metals to form complex amalgams, the object being, of course, to form imitations of silver or electrum. It is certain from these various processes that the preparation of amalgams was well understood as an art in ancient times.

Apparently the only compound of mercury known to the Ancients was the native sulfide, cinnabar. The records show that this was widely employed as a pigment and as a source of metallic mercury. The striking color of this substance must have attracted the attention of primitive men had they seen any of this rather rarely occurring mineral, but our earliest definite record is given by Theophrastus, when he describes the preparation of mercury from it. The next record in point is left by Vitruvius. This author devotes considerable space to the means of employing the compound for purposes of decoration. Apparently, the pigment was very often applied to interior walls by incorporating it with wax. Of special interest from the chemical point of view is the method used to detect admixtures of chalk with the pigment, minium. Although there is some doubt as to whether this test was applied to red lead or to the native mercuric sulfide, since the Ancients frequently confused the two, it is more probable that it was the true minium that was adulterated with chalk. The method of detecting the presence or lack of this adulterant is given in these words by Vitruvius,[11]

[10] This recipe and those following are from the writer's "The Leyden Papyrus X; an English Translation with Brief Notes," THIS JOURNAL, 3, 1149–66 (Oct., 1926).

[11] De Architectura, VII, 12.

For recognizing this fraud, it is necessary to place the minium on a sheet of iron which is heated to incandescence. If then, the minium, which was red, becomes black and on cooling regains its former color, one can be assured that it was not adulterated.

The mercuric sulfide, if pure and not heated too strongly, would act in this way, partly subliming in the black form, and on cooling be changed back to vermilion, especially if ground up again. If, however, some chalk was mixed with the pigment, this adulterant would be decomposed, partly at least, into carbon dioxide and lime in the heating with the result that the latter compound would act upon the mercuric sulfide, decomposing it and leaving a permanent black color due to the liberated mercury. Naturally the ancients did not connect any such explanation with their empirical test, but nevertheless, it is evident that the test that they did apply to detecting the adulteration was a rational and effective one from the chemical point of view.

The Greek writer, Dioscorides, also gives some information on native mercuric sulfide, but this author confuses the mineral with red lead and with the resin, dragon's blood, so that his accounts are somewhat lacking in definiteness and clarity.

Pliny makes some interesting statements on minium. Concerning its sources and occurrence, he says:[12]

It is also in silver mines that minium is found, a pigment held at the present day in very high estimation; and by the Romans in former times—used for sacred purposes as well. . . . . for my own part I am quite at a loss to account for the origin of this usage; but it is a well-known fact, that at the present day even, minium is held in great esteem with the nations of Ethiopia, their nobles being in the habit of staining their bodies all over with it.

And again,[13]

According to Juba, minium is also a production of Carmania, and Timagenes says it is found in Ethiopia. But from neither of these regions is it imported to Rome, nor, indeed, from hardly any other quarter but Spain; that of most note coming from Sisapo.

It is interesting to note that this latter locality is identical with the present district of Almaden, still famous as a chief source of the mineral cinnabar.

The fact that this mercury compound is poisonous was well recognized in ancient times in spite of the fact that it was sometimes used in medicinal preparations. On this subject Pliny says:[14]

As it is a fact generally admitted, that minium is a poison, I look upon all the recipes given as highly dangerous which recommend its employment for medicinal purposes.

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[12] Natural History, Bk. XXXIII, chap. 36.
[13] *Ibid.*, Bk. XXXIII, chap. 40.
[14] *Ibid.*, Bk. XXXIII, chap. 41.

Pliny also makes another statement of interest on the poisonous properties of the dust from this pigment:[15]

> Persons employed in the manufactories in preparing minium protect the face with masks of loose bladder skin in order to avoid inhaling the dust which is highly pernicious; the covering being at the same time transparent enough to admit of being seen through.

This was assuredly the forerunner of our modern dust and gas masks.

The synthetic preparation of mercuric sulfide for pigment or other uses was probably unknown to the ancients. The preparation of this and other mercury compounds was added to the list of known substances during the Middle Ages but it seems certain that the native sulfide was the only compound of mercury known at this early date.

[15] Natural History, Bk. XXXIII, chap. 40.

Spraying Paint Found Dangerous to Health. Spraying on paint with a gun, a process that has practically revolutionized finishing in the automobile industry in recent years, is under indictment as a source of considerable health hazard. A representative committee, appointed by the National Safety Council, has just reported upon an investigation of twenty-nine plants and groups of workmen, including automobile and vitreous enamel concerns as well as contracting painters.

Several workmen gave evidence of benzene poisoning acquired from spraying benzene lacquers, while the indications of lead poisoning were called "distinctly significant." The danger of silicosis from silica dust particles in the air was apparently not so great though three positive cases were found.

As a remedial measure the committee suggested the use of what is known as the positive pressure respirator for the general protection of paint sprayers. Persons spraying compounds of lead or benzene should receive periodic medical examination, the committee declared. It also recommended that manufacturers of paints, lacquers, shellacs and vitreous and varnished enamels to be used in spray coating should eliminate as far as possible benzene, lead and free silica from their products.—*Science Service*

Transparent Metal May Improve Radio Receivers. Sheets of metal such as iron, gold or platinum so thin that ordinary type can be read with ease through them, may find use in radio and phonograph reproducers. Ordinary diaphragms for this purpose are so heavy that they dampen some of the overtones and so coarsen the sounds. These thin metal sheets are the result of research by Dr. Carl Mueller, of the Charlottenburg laboratory, near Berlin. His method of preparing them is to electroplate the metal on the surface of some soluble substance, such as rocksalt, and then dissolve away the support. A ring of thicker metal can be used to support the films, of which two and a half million would have to be piled to make a stack an inch high.

Such films have been made of iron, nickel, gold, silver and platinum, and it is found that although the nickel is much less transparent to visible light than gold, it readily transmits the shorter ultra-violet rays. The films are very elastic, and will bulge out for as much as a tenth of their diameter without breaking. Another curious thing about them is their high electrical conductivity. Electric current is carried only along the surface of a wire, and as these are practically all surface, a strip of film containing no more metal than in a round wire one hundredth of a millimeter in diameter—scarcely visible to the naked eye—will carry enough current to light several lamps. If the same current were passed through the wire, it would be instantly melted.—*Science Service*

THE TEACHING OF CHEMISTRY IN A HIGH-SCHOOL COÖPERATIVE INDUSTRIAL COURSE

H. R. WILSON, SENIOR HIGH SCHOOL, LANSING, MICHIGAN

The Coöperative Industrial Course

In 1912, at the request of several industrial firms in the city of Lansing, the Board of Education decided to provide a course in high school whereby a boy may receive a high-school education during the time that he is learning his trade. The course has proved a great success. Twelve boys graduated from it in 1916, representing the automobile, sheet-metal, drafting, and pattern-making trades. One hundred and eighty apprentices are now in high school and are working in twenty-one trades.

The course is not college preparatory, but is primarily intended to relate the boy's school work to his training in the shops, giving him the knowledge deemed necessary for intelligent and quick solutions of many problems met during his first years on the job of learning a trade. It is also designed so that a boy may contribute to self-support while he secures an education.

The Curriculum

Trade technology, related science, economics, literature, and art are included in the curriculum. Hygiene, safety first, and first aid are given special consideration. The method used in this type of course is somewhat different from that of the usual high school and its success depends largely upon the coöperation of local industries. The student apprentice attends school on alternate weeks only. When possible, the boys are scheduled to work in pairs so that one is in school while his partner is carrying on the job in the shop. To take care of those boys during "shop" week who may be unemployed during times of industrial depression, or for other causes, the Industrial Department maintains a printing shop, machine shop, electrical workshop and drafting office in the school. These are run as nearly as possible on regular shop methods, forming a useful production and repair department for the school and homes of the students.

The curriculum specifies three semesters of chemistry. This is different in many ways from the usual high-school chemistry. It is not intended to prepare a boy for college or the business world, but to impress upon him the part that chemistry plays in his trade and to give him the knowledge of the chemistry deemed necessary for the reasonable interpretation of familiar industrial processes. Problems met, or incidents which have occurred, during work in the shops are recited during the school week and discussed in class. Many of the boys are foremen of the future and it seems necessary, during this age of scientific progress, that

they know something of the chemistry in the industry to which they belong.

The author remembers vividly an incident which occurred during his apprenticeship in an old-fashioned engineering shop. For the first time in the history of the shop, some machines containing aluminum parts were sent in for repair. They were thickly coated in oil and dirt. "Put them into the bosh," said the shop foreman. The "bosh" was a steam-heated solution of caustic soda which effectively removed oil and grease from iron and steel machine parts. But the foreman did not know that a chemical reaction takes place between sodium hydroxide and aluminum. He learned it when the remains of those machine parts were taken out of the bath after one hour of boiling. But it cost the firm about five hundred dollars to teach him the simple fact. A foreman with no knowledge of chemistry may be a good foreman, but one who knows something of the chemistry pertaining to his trade is a better one.

No Suitable Textbook

One of the hardest tasks in connection with the teaching of chemistry in a course of this type is to find a suitable textbook—one that is of high-school grade and which interprets familiar chemical facts in terms of individual trades. I suppose that there are many reasons why such a textbook has not been written, one of which is that a book which is applicable to the trades of one locality would not be suitable for a place where industries are of a different type. Another reason is that the writing of such a text would not be a very profitable undertaking because courses of this type are few. Therefore we rely to a large extent upon special instruction sheets. The fundamental theories of chemistry may be learned from the text but instruction sheets are used to relate these fundamentals to the apprentices' work.

Many textbooks give the changing of ice into water and later into steam as an example of a physical change. The burning of a match, or a piece of paper, is given as an example of a chemical change. Both are good examples but they do not bring chemistry close enough to the apprentice auto-mechanic or to the machinist. On a par with the ice-water-steam example we may substitute copper and show how a physical change takes place in the structure of a copper pipe during long service or from the vibration of a car or airplane. We show how its internal fibrous structure has changed and how it may be restored by suitable heating and quenching. When gasoline and air are exploded in the cylinder of an automobile a chemical change takes place. The original compounds are split up and some new compounds are formed. A poisonous gas is discharged from the exhaust and carbon is deposited on the head of the piston and exhaust passages. The reaction evolves heat which must be carried away, either

by air-cooled cylinder fins or by water circulating through the cylinder walls. In this way many examples must be taken from local industries to interpret chemical facts.

Skeleton Outline of the Course of Study

I. First semester of chemistry. 11th year, last half.

A. Purpose.

(*a*) To introduce the the first principles of chemistry and help the boys to become familiar with the use and care of apparatus.

(*b*) To study a few common elements and compounds.

B. Method.

(*a*) Texts and experiments in the laboratory.

(*b*) Apprentices are encouraged to bring practical topics from their work in outside plants to the class for discussion.

C. Time Allotment.

Seven fifty-minute periods per week on alternate weeks for nineteen weeks; three periods for recitation and four for laboratory work.

II. Second semester of chemistry. 12th year, first half.

A. Purpose.

(*a*) To lead an intensive study of the chemical composition of a few common materials.

(*b*) To develop the scientific viewpoint.

B. Method.

(*a*) Laboratory work.

(*b*) Articles from magazines are read and discussed. Moving pictures showing manufacturing processes are also used.

(*c*) During the study of carbon and nitrogen, trips are made to the gas plant and also to the ice plant.

C. Time Allotment.

As in the first semester.

III. Third semester of chemistry. 12th year, last half.

A. Purpose.

(*a*) To introduce the student to the structure and use of a few common organic compounds.

(*b*) To emphasize the relationship of chemistry to everyday life.

(*c*) To write an essay concerning some chemical phase of the trade which the student is learning.

B. Method.

(*a*) The textbook is used as much as possible. Articles from trade and technical periodicals are read and chemical operations which the students have observed in the shops are treated by oral reports and discussion.

(*b*) The project selected by the boy and the resultant essay involves library reading and laboratory research in different fields of chemistry.

C. Time Allotment.

Nine fifty-minute periods on alternate weeks for nineteen weeks; one period for recitation and eight for laboratory work.

The "mathematics" of chemistry is not stressed and only a few elementary problems involving molecular and atomic weights are given. Sufficient is provided to ensure an intelligent comprehension of articles relating to chemistry in trade magazines and popular periodicals. Recently I was much interested in a controversy between various educational science authorities on the question of laboratory work. Some state that we should cut down—if not altogether abolish—the amount of laboratory work done by a student, making him dependent on demonstrations performed by the teacher, as a substitute. Such a procedure would certainly not suit the class of students found in a course of this type. Being largely of a motor-minded type they learn by doing the work in the laboratory. They receive a training in the shops which keeps them constantly on the move and it seems a hard task for them to sit and listen to a lecture for many minutes. The more manipulative work they receive in conjunction with their studies the better will they enjoy the subject and so much less will the instructor's disciplinary problems become. The reader will notice that the course of study specifies eight periods of laboratory work and one period of lecture per week during the third semester. The laboratory periods include individual conferences between student and teacher, and some library reading. The one period of lecture is devoted to student talks and special instruction on subjects common to all the trades and relating to chemistry.

The Essay

In the last semester of chemistry this essay forms the major part of the students' work. The requirements of their English class are coördinated with it and all outside reading is in connection with some topic pertaining to it.

A brief outline of other requirements is given below.

1. The length of essay to be no less than 2500 words. This may include the descriptive writing of either sketches or other illustrations.
2. It must be presented in book form and contain a bibliography.
3. Where possible it must be accompanied by an exhibit of materials mounted on thick cardboard of standard size. This may later be used to fill a panel in the chemistry lecture room.

A few of the essay projects which may be chosen by the students in different trades are listed below.

Electricians

1. Batteries
2. Chemical Rectifiers
3. Electroplating

4. Insulators
5. Copper.

Builders. (This group includes boys employed in the sheet-metal, plumbing, painting, and carpenter trades.)

1. Water-softening and purification
2. Wood and its preservation
3. Corrosion
4. Steel and concrete
5. Asbestos and plaster.

Auto-Mechanics

1. Gasoline
2. Alloys used in automobile manufacture
3. Rubber
4. Oil and grease
5. Anti-knock fuels.

Printers

1. Paper
2. Inks
3. Loading and sizing
4. Electrotyping and engraving.

Machinists and Tool-Designers

1. High-speed and other steels
2. Alloys of iron
3. Non-ferrous alloys
4. Cutting lubricants
5. Blue-prints and other photography.

Special Experiments

Although the boys are urged to use their initiative and knowledge in the special laboratory work in connection with their topic I have found it necessary to write some experiments for their guidance on individual work. Here is one that is used by a student electrician who may choose "Chemical Rectifiers" for his essay topic.

XXIV CHEMICAL RECTIFIERS

A. Apparatus:

Large beaker, electrode holder, lead electrode, aluminum electrode, iron electrode, arc lamp carbon, switch, 50-watt lamp and socket, wattmeter, d. c. voltmeter and ammeter, socket plug with wire connections, clips and wire for connecting apparatus, source of 110 volt a. c. current.

B. Information:

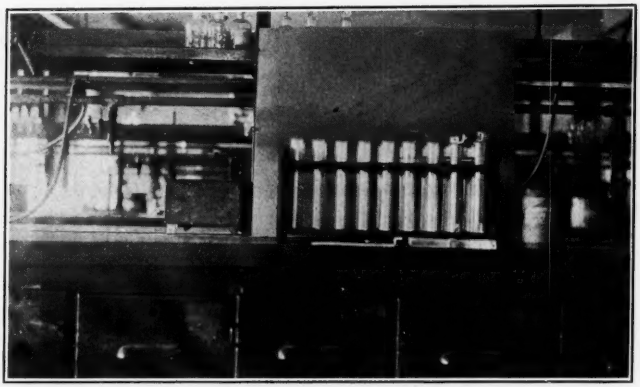
In our previous experiment the electrodes were of lead and aluminum. These have their disadvantages, although aluminum is probably the best metal for a positive electrode in this type of rectifier. If the rectifier is left idle for a few days some of the lead dissolves and deposits on the aluminum as metallic lead. This will appear as a black film on the surface of the aluminum, and no rectification will go on while the deposit remains. It has been found that the lead is not deposited on the aluminum while any of the hydroxide film remains.

C. Method.

1. Reconstruct the circuit shown in Experiment 249.23:5. Remove the lead electrode (now covered with a brown coating of lead peroxide PbO_2) and substitute iron in its place. Switch on the current and take readings of the meters. Take readings every five minutes for thirty minutes and note any change in the appearance of the iron. Probably you will notice a brown precipitate falling from it.

2. Take a sample of the solution containing the brown precipitate in a test tube, add a little HCl, warm, and add a few drops of potassium sulfocyanate (KCSN). Note the change in color which has taken place. What do you think the precipitate was? Make an equation showing the probable reaction which took place when the HCl was added to the solution.

3. Substitute in place of the iron, an arc lamp carbon of suitable size, and test the

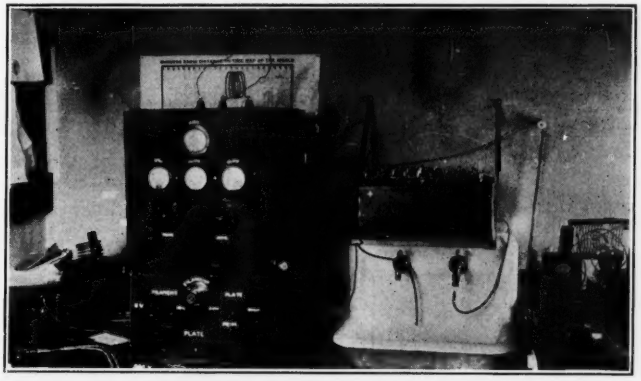


A CHEMICAL RECTIFIER IN THE PROCESS OF CONSTRUCTION

efficiency of the rectifier. Do you notice much difference in the reading of the meters? Try the solutions given in the table below.

4. Copy the following table in your notebook and complete it. In the "notes" column, state any unusual occurrence (excessive gas evolution at electrodes, change in color, etc.), which you may notice.

Solution	Input watts	Output (Amp. Volts)	Efficiency	Notes
a. Dilute solution of sodium bicarbonate.				
b. Saturated solution of borax.				
c. Solution of potassium permanganate.				
d. Saturated solution of potassium permanganate.				
e. Solution of ammonium phosphate.				
f. Solution of sodium-potassium-tartrate.				
g. Solution of ammonium acetate. and a little sodium bicarbonate.				



TESTING A CHEMICAL RECTIFIER

The test tubes containing Al and Pb electrodes are immersed in a bath of running water. The rectifier shown passes a current of 150 milliamperes at 1800 volts to the transmitter at the right of the picture. Rectifier and transmitter were both constructed in the Industrial Department workshops.

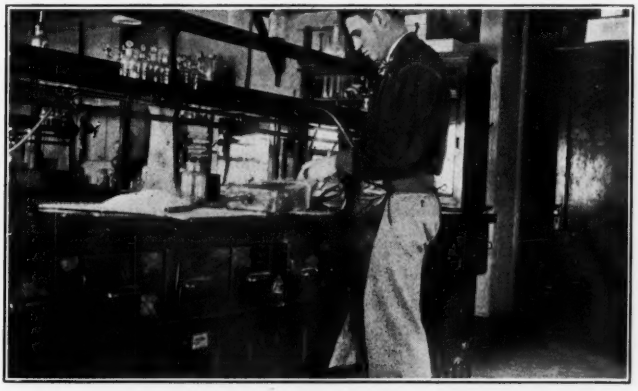
D. Questions.

1. Into what two classes may electrolytes generally be divided? Give the advantages and disadvantages of each class.

2. What advantages would a carbon electrode have over lead or iron, in most organic electrolytes?

3. How may the deposition of lead on the aluminum electrode be prevented in an organic electrolyte?

4. For what reason may solutions of ammonium salts be a little better to use than salts of sodium or potassium?



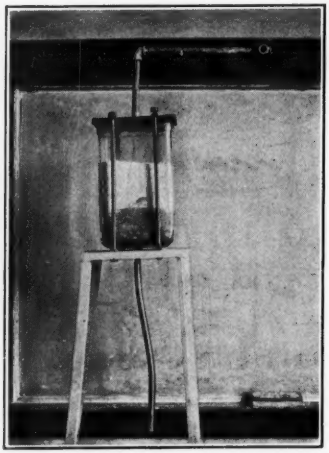
FILLING A WATER-SOFTENER

The parts were constructed in the school shop.

E. References.

"Q. S. T.," May, 1927, pp. 33–35. "Chemistry," by Greer & Bennett. Chap. XIV.

After the experiment is completed, the boy constructs a rectifier which is tested under actual working conditions in the radio operating room. This contains two transmitters, on wave-lengths of twenty, forty, and eighty meters, which are used for experimental work and interschool communication with other high schools. The following experiments would be completed by a boy in the building trades who had chosen "Water-softening and purification" for his essay topic:



A WATER-SOFTENER READY TO BE INSTALLED FOR TESTING

It contains a layer of gravel, a layer of sand, and a thick layer of zeolite. The Electrical Department supplied the glass cell, which was drilled in the mechanical workshop.

1. Settling suspended matter in water, using alum.
2. Purification by chlorine, potassium permanganate.
3. Softening by lime and soda method.
4. Construction and test of a zeolite softener.

The student interested in "Alloys Used in Automobile Manufacture" has laboratory work which includes simple qualitative tests for common metals. If sufficient progress is made, two or three of the following quantitative experiments are tried.

1. Standardization of a $KMnO_4$ solution for the determination of iron.
2. Analysis of wrought iron, cast iron, and steel.
3. Standardization of a KCN solution for the determination of copper.
4. Analysis of brass.

Conclusion

Such a chemistry course as I have described is probably only applicable to a high-school course for a special type of student. For the instructor it means a considerable amount of preliminary work in writing of special experiments and instruction sheets and carrying more than the usual list of material in the chemistry stockroom. But it certainly carries into the work an interest and variation not found in the usual semi-routine work of the textbook type of high-school chemistry.

THOMAS GREEN CLEMSON, LL.D., THE CHEMIST.* PART I

R. N. BRACKETT, CLEMSON COLLEGE, SOUTH CAROLINA

Thomas Green Clemson, mining engineer, chemist, geologist, diplomat, agriculturist, first Superintendent of Agricultural Affairs of the United States, and philanthropist, was born at Philadelphia, Pennsylvania, July 1, 1807, and died April 6, 1888, at "Fort Hill," his plantation in Oconee County, South Carolina, now the seat of The Agricultural College of South Carolina, which he founded.

The Clemson family was one of the pioneer families of the wilderness North of Gap Mountain and the Pequea Valley, now Salisbury township, Lancaster County, Pennsylvania, and the members of this family were among the most eminent families of the Society of Friends, at the time the old Salisbury meeting was first established, in the year 1724.

The record indicates that at least six members of the Clemson family served in the Revolutionary War. Two were Majors, and one Colonel of the War of 1812. The Civil War records indicate at least two on the Southern side. At least one was in the Mexican War, and three in the Spanish-American War, and ten in the World War.[1]

The prominence of the family of Thomas G. Clemson is indicated also by certain marriage connections, notably that his sister Louisa married Dr. Samuel Washington, grand-nephew of George Washington.

James Clemson, grandfather of the subject of this sketch, seems to have been a farmer, having purchased, in 1702, a tract of 136 acres of land in Bethel township, Delaware County, Pennsylvania, where he made his home and reared a family of seven children—four daughters and three sons, John, James (2nd), and Thomas. The three brothers settled in Lancaster County. Thomas, however, father of Thomas G. Clemson, moved to Philadelphia, where he was a well-to-do merchant, and here Thomas Green Clemson was born.

"As a boy he evidently attended the Central High School of this (his native) city, graduating there, and later graduating from the Ecole des Mines of Paris."[2]

At the age of nineteen, Thomas G. Clemson, for some unknown reason, left home to seek his fortune in Europe, sailing for Paris, but spending some time in England on the way. He seems to have spent the greater part of the period from 1826 to 1836 in Paris.

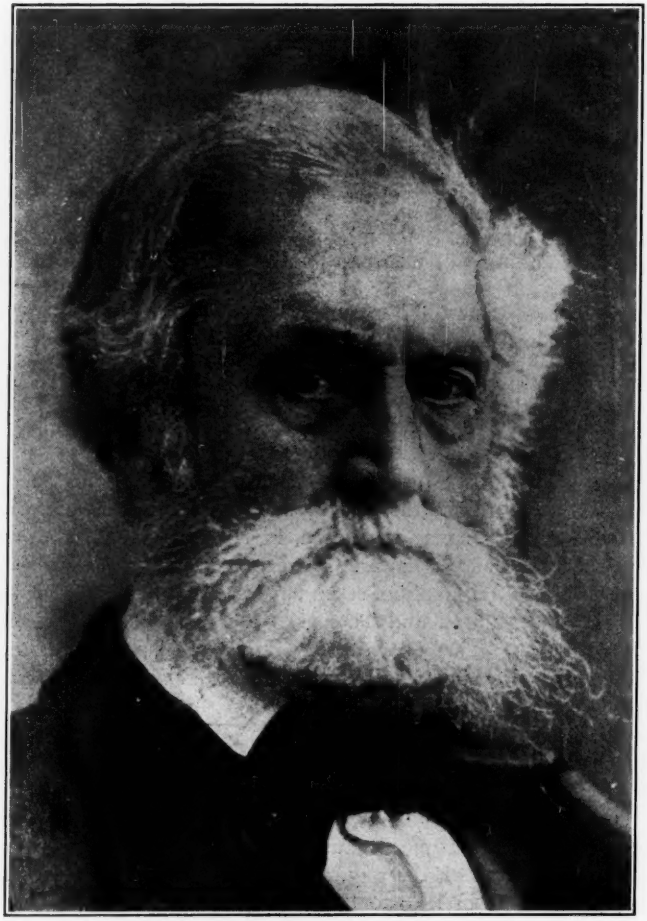
At the instance of Dr. E. W. Sikes, President of The Clemson Agri-

* Paper read before the joint session of the Division of Chemical Education and the Section (now Division) of History of Chemistry at the 73rd meeting of the American Chemical Society at Richmond, Va., April 14, 1927.

[1] Papers of A. G. Holmes, Professor of History, Clemson College, S. C., on the Life of Thomas G. Clemson. (These papers were published serially in the *Greenville News*, Greenville, S. C.)

[2] Letter of Dr. Edgar F. Smith, Dec. 15, 1926, to the writer of this sketch.

cultural College of South Carolina, and with the coöperation of Mr. G. F. Mitchell, an alumnus of the college and now of the Department of Agri-



HON. THOMAS GREEN CLEMSON, LL.D.
1807–1888

culture, Bureau of Chemistry, Washington, D. C., and through the courtesy of Mr. Robert P. Skinner, Consul General of the United States at Paris, the Director of the École des Mines in Paris wrote Mr. Skinner a letter, giving the connection of Thomas G. Clemson with that school, where some

thought Mr. Clemson had been pupil and afterwards a teacher. The letter reads as follows:

Ministere des Travaux Publique
Paris, July 1st, 1926
Boulevard St. Michel 60

Ecole Nationale Surrieure des Mines
To Mr. Robert P. Skinner,
Consul General of the United States of America
1, rue des Italiens, Paris

Mr. Consul General:

I had not lost track of your letter of June 10 regarding the passage of Thomas G. Clemson at the Paris School of Mines, but up to the present time, I had made a fruitless search through our archives which consist of the minutes of the council of the school on hand since 1816. I have been unable to find any record of a student by the name of Clemson either in the minutes or the directory of former students of the school. However, I entertained some doubts on the matter as a note under date of Nov. 4, 1828, indicated that a young American by the name of Clauson was authorized to attend classes at the school of mines through a decision rendered by the ministry of the public works at the request of the consul of the United States of America. A further search of our archives revealed the fact that the Clauson of 1828 was none other than Thomas Clemson. The archives of the secretary's office contain a file of slips on each regular student and each "auditeur libre" (irregular student) who has passed through the school (white slips for regular students, and blue for "auditeur libres") and a blue slip has just been discovered in the name of Clemson (Thomas), 1828–1832, which means that Thomas Clemson attended the classes at our school as "auditeur libre," from 1828 to 1832; therefore, the Clauson of November 4, 1828, can be no other person but Thomas Clemson.

The minutes of the council give no information in regard to "auditeurs libres," who, until recent years, were subject to no examination and were granted no diploma nor degree. I have, therefore, been unable to ascertain, other information beyond the fact of his admission to the school in regard to "Auditeur" Clauson, as identified with Thomas Clemson. At any rate, it is quite certain that he never was a teacher in our institution.

Please accept, Mr. Consul General, the assurance of my most distinguished consideration.

The Director of the School of Mines
(*Signed*) *Chesneau*

In 1830 Clemson took part in the movement to overthrow King Charles X, and place in his room Louis Phillipe as constitutional monarch. Louis Phillipe had spent some time in Philadelphia, and had possibly visited in Clemson's home.

During the year 1832 Clemson visited the United States, but returned to Paris the same year and remained there probably through 1836. In 1837 we find him back in the United States, practicing as consulting engineer and chemist at Philadelphia and Washington. In the latter city he met Anna Maria Calhoun, John C. Calhoun's favorite daughter, whom

he married November 13, 1838, at "Fort Hill," then the estate of his father-in-law in Oconee County, South Carolina.

Clemson lived in the South from 1838 to 1844, part of the time at "Fort Hill," and for two years on his plantation, "Canebrake," of 1000 acres in what was then Edgefield District, purchased together with twenty slaves in 1843. During this period he was actively engaged in his profession as a mining engineer by correspondence and in travel. He made several trips to Philadelphia, and one to Cuba in the early part of 1842. In a letter to Calhoun written from "Fort Hill," January 10, 1841, he says:

> Since I wrote to you last, I have received an offer to take the direction of a mine in the environs of Havana. It is a regular deposit of a substance resembling coal in its physical characters and is what is known as "chipopota," or mineral bitumen. I have accepted appointment so far as to make a preliminary visit, provided they agree to my terms, which are $1500, not including traveling expenses. The terms are high, but considering the duty and distance, not exorbitant.

In 1843 we find Clemson making frequent visits to a gold mine, the "O'Bar" at Dahlonega, Ga., owned and operated by Mr. Calhoun. Clemson seems to have had charge of this mine, which was worked winter and summer with slave and white labor.

In 1844 Clemson was appointed Charge d'Affaires to Belgium. In a letter to Mrs. Clemson, May 5, 1844, Mr. Calhoun writes:

> I saw the President (Tyler) day before yesterday, and asked him if he had disposed of the mission to Belgium. He said he had not, and that it was at my disposal. I named Mr. Clemson to him. He readily assented, so that, if he desires to fill it, it is at his service. The present Charge will leave in August. It is near Paris, and I suppose will suit him better than the one at Naples, which will not be vacant until next year. He must let me know soon.

Clemson and his family accordingly went to Brussels, where they resided until 1851. "Mr Clemson was eminently fitted for this post by training, knowledge of European conditions, familiarity with the language, as well as in temperament."[1]

Closely following the death of his father-in-law, John C. Calhoun, at Washington, March 31, 1850, Thomas G. Clemson resigned the diplomatic post in Belgium, and with his family returned to the United States. He then had a home at Glen Cove, Long Island, N. Y., and also the "Canebrake" plantation in South Carolina, and during the next two years he spent his time between the two. These two places he sold in 1851, and purchased in 1853 a country place which he named "The Home," on the Bladensburg road four miles from Washington, in Prince George's County, Maryland.

During the years 1853 to 1861 Thomas G. Clemson resided at "The Home," operating a farm, writing scientific papers, especially from 1855 to 1861, for the *American Farmer*, published at Baltimore, Md., and also

having been connected with the Agricultural Division of the Patent Office, during the same period (1855–1861). By request he wrote a paper on Fertilizers for the 1859 Report of the Patent Office, Agricultural Division, which paper was continued and completed in the 1860 report, when Mr. Clemson was Superintendent of Agricultural Affairs of the United States. It was also during this period that Mr. Clemson displayed in his published papers and in his support of the movement for the establishment of the Maryland Agricultural College, his intense interest in scientific education. In the 1860 Report of the Patent Office, Mr. Clemson strongly advocated the establishment of a United States Department of Agriculture, outlined its scope, and emphasized the importance of an efficient chemical laboratory as part of the organization.

Threats of war put an end to Mr. Clemson's connection with the Patent Office, though he kept his office until March 4, 1861. Mr. Clemson had been nearly ten years a resident of Maryland, and had sold all of his South Carolina property and all of his slaves to the number of forty. He was fifty-four years old, beyond military age, and, therefore, might have remained quietly in Maryland as a neutral during the war between the States, which began in April, 1861. But Mr. Clemson was Southern in his views and sympathy, and being eminently a man of action and definite convictions, he could not be neutral.

It was known to the Administration that Mr. Clemson was a Southern sympathizer, and while his arrest was pending, having been warned, he with his son, John Calhoun, escaped across the Potomac in an open boat, walked to Richmond, Va., and offered their services to the Confederate Government, then continued their journey to Pendleton, S. C., where they awaited orders and assignments.

Mr. Clemson was assigned to the Army of the Trans-Mississippi Department of the Confederacy. He served in several capacities in connection with the mining and manufacture of materials for explosives, evidence of which is in the records of the "War of the Rebellion." At the time of the surrender of this Army by General Kirby-Smith, Mr. Clemson was serving as Supervisor of Mines and Metal Works. He, therefore, saw about four years of service during the war.[1]

After the war, Mr. Clemson joined his family at Pendleton, S. C., and from this time until his death in 1888 lived either at Pendleton or at "Fort Hill." Mrs. Calhoun sold the "Fort Hill" estate, with all the slaves, to her son A. P. Calhoun, who died during the war with the bond and mortgage unpaid. Mrs. Calhoun brought suit for foreclosure against the estate, but died July, 1866, in the midst of the suit, having willed the estate, one-fourth to her granddaughter, Floride Clemson Lee, and three-fourths to her daughter, Mrs. Thomas G. Clemson. The "Fort Hill" estate was then sold at public auction, bought in by Thomas G. Clemson, acting for his wife and daughter, for $15,000, Mr. Clemson also paying out of his

own funds the cost of litigation, amounting to something less than $7000. In the same year, 1871, when Mr. Clemson came into possession of "Fort Hill," news was received of the death of his daughter at Mt. Carmel, N. Y., and seventeen days later his only son, Captain John Calhoun Clemson, was killed in an accident, while a passenger on the Blue Ridge Railway. Thus were Mr. Clemson and wife bereft of their three children, the youngest daughter having died in 1855.

Mr. and Mrs. Clemson, now living at "Fort Hill," "began to plan some use of the estate which would forever make 'Fort Hill' a shrine to John C. Calhoun, a memorial to their soldier son, and at the same time serve some useful purpose in aiding the young men of South Carolina, who might be interested in scientific and agricultural education."[1] Each, therefore, made a will in favor of the other to this effect. Mr. Clemson survived his wife and left the "Fort Hill" estate, together with about $60,000 in money for the establishment of The Clemson Agricultural College of South Carolina, provided the State of South Carolina would accept the terms of his will and maintain the college.

As a man, Thomas Green Clemson was physically large, six feet six inches tall and well-proportioned. He spoke and wrote and had the manner of a man of great learning, yet with scholarship he combined in a rare degree keen aptitude for business. He was intensely methodical and prompt in attention to all matters demanding his attention. Generosity as well as thrift was a prime virtue with Dr. Clemson. When living the lonely life of a recluse at "Fort Hill," all immediate family lost, he was so bent upon saving every possible dollar to pass on to the youth of his adopted State that his attorney had to urge him to buy a new buggy to protect him from rain and storm. Dr. Clemson was most generous to those who served him and kindly and considerate to all lowly persons who were worthy, but had little patience with idlers and loafers.[1]

Clemson as a Chemist

It has not been found that Dr. Clemson made any contribution to the development of chemistry as a science, but that he had an exceptional grasp and clear understanding of chemical facts and principles, was a competent analyst, and that he had a keen appreciation of the dependence of agriculture and industry on chemistry, that he urged the importance of scientific and especially chemical education, and finally that he strongly advocated the establishment of a United States Department of Agriculture with an efficient chemical laboratory, are all abundantly shown in his writings. He lost no opportunity to emphasize the value and necessity of scientific education, and as the closing act of his long and active life established The Clemson Agricultural College of South Carolina.

During the period 1830 to 1836, part of which time he was a student at the School of Mines, and at the Royal Mints, and the remainder still living in Paris, fifteen papers were published under Clemson's name and one jointly with R. C. Taylor. Of these fifteen papers, twelve were dis-

tinctly chemical, assays and analyses of iron ores, minerals, hydraulic limestone, copper ore and coals; one on piperin; and one on the method of manufacture of Nordhausen sulfuric acid in Germany. The other three papers by Clemson were on the physical geography, etc., of The Hartz; geological examination of the country between Fredericksburg and Winchester, Va.; native iron from Yates County, New York. The joint paper of Clemson and Taylor was on a vein of bituminous coal in the vicinity of Havana, Cuba. The full titles and references are given in the bibliography which will accompany Part II of this sketch.

The following quotations, which throw light on the activities of Clemson as a chemist, are taken from a letter[3] written by him to Jas. T. Earle, Esq., President of the Maryland State Agricultural Society, in response to an invitation to deliver an address on the Importance and Advantage of a Scientific Institution for the Advancement of Agriculture, on the evening of the 22nd of October, 1856, an invitation which Dr. Clemson was unable to accept because of a peremptory business engagement in New York City:

> It may be interesting, and is certainly not irrelevant that I should mention here some facts illustrating the use of science as an aid in the practical business of life, for which I can personally vouch.
>
> When a member of the Royal School of Mines of France, Mr. Pierpont of New York put into my hands a specimen of iron ore, which, he stated, existed in large quantities in that state. Furnaces had been erected, and a large amount of capital had been expended for treating the ore. It was smelted, but the iron obtained was, from some unknown cause, too indifferent to be used. The furnaces went out of blast, and they either had, or intended, abandoning the undertaking at a large loss of capital. I examined the ore given me, and to my surprise found the result of the first essay to be a natural steel. This gave increased energy to the undertaking, and I have understood since that an immense business soon sprung up in manufacturing scythes, axes, etc.
>
> To come to our own State—Mr. Ed. Patterson, of Baltimore, discovered a variety of iron ore, which baffled the best efforts to treat. Half a ton of the ore was barrelled up, sent to Havre, and thence to the School of Mines in Paris. I made an examination of it, and found it to be titaniferous and forwarded the result, together with the mode of treatment, to Mr. Patterson, which was successfully put into practice, and I have heard greatly to the pecuniary advantage of the proprietors.
>
> On my return to the United States, I was invited by his brother, Mr. Geo. Patterson, to visit his estate, situated in Howard County, and near Sykesville, for the purpose of making a scientific reconnoissance of the surface indications of his fine farm. I went there, and gave Mr. Patterson my views. I must mention that, at that time, according to the best of my recollection, no idea of the existence of copper there was entertained by any one. After a long absence in Europe, I met Mr. Patterson, who told me that my statements had been verified, and that a shaft had been sunk, from which they were extracting quantities of valuable copper ore. I have visited the locality since, and found the operations in progress.

[3] Letter of Hon. Thomas G. Clemson to Jas. T. Earle, President of the Maryland State Agricultural Society, Oct., 1856, *American Farmer*, Baltimore, Vol. XII, 1856–57.

In some of my geological examination, I found, particularly in Jefferson County, Virginia, strata of limestone, and on analysing them, they proved to be natural hydraulic cements, which have been profitably manufactured with great advantage to the community.

Far up in the interior of Carolina, where mineral fertilizers appear to be wanting, I discovered a large formation of decomposed feldspar, which when added to the impoverished soil, greatly increased its fertility, and I have not a doubt that it still is, and will continue to be, used as a fertilizer.

In the same letter,[3] illustrating the fact that "in all pursuits of life, whether we study health, wealth, or comfort, science is an unerring guide," he says:

Another instance, even more general in its effects, since it touches the pockets of every individual in the nation, is to be found in our currency. It has been known for many years that our silver coin is constantly flowing out of the country, and going out of circulation. To prevent this, government has had recourse to debasing the coin; but even that was insufficient and the constantly recurring want of a sufficient silver currency has given rise to enormous issues of small bank notes. Now, for the cause of this mysterious disappearance. All, or most silver—particularly that of Mexican and South American origin contains gold. The mints of European nations being in the hands of scientific men—those governments being fully aware of the value of scientific knowledge in that position—this gold, when existing in sufficient proportions or importance, is abstracted for the profits of governments before the silver is thrown into currency. In the United States where a different state of things exists, those engaged in our mints, either from want of knowledge, or indifference to the interest of our country, have coined the silver without any attention to this fact. The consequence is that it has been found profitable to purchase our silver coin even at a premium, ship it to Europe where it pays a profit to separate the gold. Even the sweepings of the mints of the United States are so valuable that they are carefully saved, barrelled, and sold for shipment to Europe, where the small quantities of the precious metals contained are profitably separated. These facts I learned when a student in the Royal Mints of France, many years since; and when in an official position in Belgium, some years ago, I had occasion to see large amounts of our silver coin fresh from the die, undergoing, in the mints of Belgium, the operation for separating the gold, and when recalled by my Government, I was offered the agency for purchasing and collecting it for shipment to Belgium.

A few quotations from a letter by Dr. Thomas Antisell to the Editor of the *American Farmer*, December 28, 1860,[4] on "Phosphoric Acid in the Air," a fact discovered by Dr. Clemson, may be of interest:

In the number of your excellent journal for May, 1856, Mr. Clemson states, from his own inquiries and experiments, that phosphoric acid exists in the air and in the snow and rain water percolating through the atmosphere. This deduction is quite original on his part, and he deserves much credit for the clearness of the enunciation and the continuousness of the exposition of the means by which this acid is found as a normal constituent of the atmosphere: I mean the infusoria and animalculae which exist everywhere. These organisms are at work unceasingly—their labor is never ending, and though invisible and their separate action inappreciable, the consequences of it are infinite. They exist and are at work in air, earth, and water, and in all kinds of matter,

[4] *American Farmer*, Vol. II, 1860–61.

and they assimilate from one and the other and prepare food for higher and more perfect organisms. (*American Farmer*, May, 1856, Vol. XI, page 330.) In a letter addressed to the President of the Maryland State Agricultural Society, in October, 1856 (*ibidem*, Vol. XII, page 162), he repeats the statement and declares the presence of infusoria and the decomposition of animal matter to be abundant sources of ammonia and phosphoric acid in the air. In the paper on microscopic organisms, published in the *American Farmer* for October, 1857,[5] the fact of the presence of phosphoric acid in the air being dependent upon minute organisms floating in that medium, is distinctly pointed out; and this whole matter was strongly set forth before the United States Agricultural Society at the meeting for 1857. The novelty of the fact stated then struck the writer of this with considerable surprise at the time, but the sources from which the aerial supply may be derived having been made manifest, we may look upon it as an acknowledged fact that this acid—the phosphoric—must be looked upon as a normal constituent of the atmospheric air.

I have been led to make the foregoing general observations upon the atmospheric constituents, and the new fact with regard to it with which Mr. Clemson has enriched science, because I perceive that in the "*Presse Scientifique de deux monds*" for 1st. December, 1860, a statement that M. Barral, a French chemist of considerable eminence, has communicated to the Academy of Sciences a similar discovery, which he asserts he made lately, but which he had suspected seven years ago, namely, the presence of phosphoric acid in the air. In the French journal alluded to, extracts are made of M. Barral's memoir, showing the amount of acid which he obtained from rain water. It is not often that discoveries are made by men of science in this country in anticipation of European chemistry, as has happened in this instance, and when made, as they have been so lately in Europe, the effect will be that the credit of this discovery will be given to M. Barral and not to the present Superintendent of the Agricultural Department of the United States, to whom it justly belongs. As the original memoirs and communications of this discovery have been made to your journal, I take the opportunity of publishing, through your columns, the facts of the case, which show that this discovery, now claimed by France, was made before, and published in this country in the columns of the *American Farmer* in 1856. We cannot afford to lose any stand-point we have gained in this country, and, if M. Barral really made this discovery, he is only a second and later discoverer of a fact previously known and published, and therefore truly stands in the light of no discoverer at all. M. Barral in 1852 presented a memoir on the composition of rain water, collected in the Observatory of Paris, to the Academy of Sciences, a report upon which was made to the Academy by Arago: in that memoir is no mention of phosphoric acid made nor any suspicion of its existence breathed. If M. Barral since discovered the presence of phosphoric acid, he only published it now and loses therefore the merit of being the discoverer by all rules applied in contested cases. If, sir, you will make these facts public, you will do our country service in the eyes of the world and place our countryman *rectus in Curia.*

In his article on fertilizers,[6] Dr. Clemson makes several references to his laboratory. In writing of water, he says: "There are waters so pure, even river waters, that at times evaporate without residuum. Such is the case with that of the Schuylkill, at Philadelphia. We have used it for months together, in analysis."

Again he gives[6] a method of examining marl, which would enable any

[5] *American Farmer*, Vol. XIII, 1857.

[6] Annual Report of the Patent Office, Agricultural Division, 1859.

"educated farmer to make an analysis in which he can confide, rather than pay a sum of money, often for false returns, with which the charlatan is always ready." The method is as follows:

A marl is valuable in proportion to the amount of carbonate of lime that it contains. Take a piece of the substance suspected to contain the carbonate, large as an acorn, throw it into a tumbler or wine-glass, and cover it with water; after the air has escaped from the interstices, add a few drops of an acid, say nitric or muriatic, or either of these being wanting, strong vinegar may suffice; then, if there should be a disengagement of gas, or effervescence, it is pretty sure evidence of the presence of carbonate of lime. In order to ascertain rigorously the amount of carbonate that may exist in the mass, we should select an average sample. The first operation consists in drying perfectly, to drive off the hygrometric humidity, which varies according to the state of the atmosphere. Reduce the matter to powder, if it requires it, and place it upon a plate. By setting the plate upon a vase containing boiling water, and maintaining the temperature for a sufficient time, all the water not combined will be driven off; and this may be ascertained by placing over the powder a glass funnel, on the inside of which the humidity will be condensed until it entirely ceases to appear. The funnel serves another purpose, that of excluding any accidental impurities, and preventing the steam, which naturally escapes from the water below, being condensed upon the powder. When the substance is thus perfectly dried, weigh fifty or one hundred grains, and place them in a silver or iron spoon (we mention the iron spoon as a substitute for the preferable platina crucible), and heat over a few live coals to a dark cherry-red. If the presence of organic matter be suspected, the powder may be carefully stirred with a piece of clean wire, in order to bring the different parts in contact with the atmosphere, when any carbonaceous matter will thus be burned. Now let the powder cool, weigh it carefully, and you have the amount of combined water or volatile matters driven off. The heat should not be so great as to drive off the carbonic acid from the lime.

Throw the powder thus calcined into a glass tumbler, and cover it to the depth of half an inch with rain-water, to which add, by degrees, a few drops of nitric or muriatic acid, until you find that the addition of the acid produces no more effect. Mix the whole with a glass tube, cover the glass, and let it stand for several hours. Now fill the glass two-thirds with water, and let it settle. When the sediment or insoluble portion, has subsided, and the liquid is perfectly limpid, decant it carefully into a large bottle, and put more rain-water on the sediment, allow it to settle, decant again, and repeat the operation until the sediment is entirely cleansed of the acid solution. This may be verified by taking a piece of clean glass, and putting a drop of the solution upon it. Now, if you hold this glass over the fire until the drop of water is evaporated, you will find it sufficiently washed when there is no residuum left on the glass. The lime, magnesia, some alumina and iron, if they are present, will be found in solution in the water decanted. The sediment, which was not dissolved by the acid, contains the sand and insoluble substances. This may be collected upon a filter, carefully dried, separated from the filter, calcined in a spoon, as before, and cooled and weighed.

If the solution be very acid, or the amount of water too large to manage well, they may be collected and evaporated to dryness over a slow fire; by this operation the excess of water and acid is driven off which may also be performed in a porcelain capsule, but by no means employ a metallic vase, as the acid would dissolve the metal, and your labor would be useless. When the excess of water has been driven off, together with the excess of acid, if the heat has not been carried too far, the whole will be found to re-dissolve in rain-water, to which a drop or two of acid may be added to insure that result. You now have nearly a neutral solution of the salts dissolved by the acid.

The next operation consists in precipitating all the constituents held in solution, less the lime. For this purpose use lime-water. To prepare lime-water, put lime, say a piece as large as a walnut, in a bottle of rain-water, shake it well, and allow it to settle; decant, and you have a limpid solution of lime in water. This water, added to the solution containing the soluble substances of the marl until a further addition produces no further precipitate, throws down everything in solution but the lime. Let the precipitate settle and decant. Throw the precipitate in a filter, and carefully collect, dry, and weigh. Your analysis will stand thus:

Volatile matter, water, organic matter, etc.	W
Insoluble residuum, sand, silicates, etc.	X
Precipitate by lime-water, iron, magnesia, etc.	Y
Carbonate of lime, by difference	Z
Equal	100

If it should be thought desirable, either of the quantities X and Y may be taken up separately and examined in detail. If phosphoric acid be present, it will be found combined in the precipitate Y, in combination with the iron or magnesia.

The above method is one that we have practiced very often, and is the most simple that we can offer to the inquiring reader who has not devoted much of his time to chemical examinations.

Dr. Clemson also refers to his laboratory in his remarks about the suggested use of "sulphate of barytes" as a fertilizer.[6] A few quotations may be interesting:

Another assertion, which has its advantages, gives the entire credit of the action of gypsum to the sulphuric acid which it contains; and this appears to be supported by the fact that the addition of the sulphate of barytes is followed by as strongly marked results as those that are derived from the application of the sulphate of lime. Experiments were made some years since in Rockbridge County, Virginia, by Dr. Barton, upon whose farm a deposit of the sulphate of barytes was found. It was ground and applied. We are informed by an intelligent observer that the effect was manifest five years after. A paper was written at the time, and published in one of the agricultural periodicals of Virginia. We have not had access to the article, but Dr. Barton received the award of a gold medal for his investigations. Should the usefulness of sulphate of barytes be confirmed, it will be a notable and important addition to the list of fertilizers.

. . . But we will here remark that, in our laboratories, the sulphate of barytes is found to be one of the most stable of salts, and its combination is in no instance decomposed by lime or ammonia. Nor does barytes form a constituent of any vegetable or animal organism within our knowledge.

Clemson's interest in agricultural chemistry is shown by the numerous papers on this subject which were published in the *American Farmer*, but more especially by his two papers on "Fertilizers," published in the Patent Office Reports, Agricultural Division, for 1859 and 1860. Together these two papers constitute a scholarly, and for the time very complete treatise on agricultural chemistry, and show a thorough knowledge of the status of chemistry, both as a science and in its applications, especially to agriculture, but to industry as well. His familiarity with the litera-

ture of chemistry and its applications, past and current, is abundantly shown by numerous quotations and citations. These papers contain a number of original suggestions and interpretations, and several references to his laboratory and work, which prove that Dr. Clemson was a practical chemist of ability. The first paper occupies 42 pages, and the second 45 pages, exclusive of from 18 to 20 pages of tables of analyses of ashes, plants, peats, and coals.

Other papers on agricultural chemistry will be found listed in the bibliography which will accompany Part II of this paper including sources of ammonia; microscopic organisms, in which he mentions the occurrence of phosphoric acid in the air; marl formations, their composition and value, etc.

Leprosy Drug Now Administered Painlessly. A new combination of chaulmoogra oil with benzocaine has enabled several lepers at the National Leprosarium at Carville, La., to receive the benefits of the curative drug with a minimum of pain.

The discomfort which accompanies the administration of chaulmoogra oil is a problem with which specialists in leprosy have struggled for years. Consequently the success which has attended the use of benzocaine-chaulmoogra oil by Dr. Frederick A. Johansen of the U. S. Public Health Service on 24 lepers at the leprosarium may mark an important step forward in the treatment of this ancient disease.

"This preparation has the advantage of not causing pain, and of absorbing readily," Dr. Johansen stated, "thereby giving the patient a uniform amount of chaulmoogra oil in a definite period of time. Since the treatment was started 36 patients have been added, making a total of 60 who are taking the injections semi-weekly as routine treatment.

"In reporting these cases," added the surgeon, "no claim is made that the injection of chaulmoogra oil with benzocaine will cure leprosy. It is felt that the method suggested is worthy of further use and such trial as may seem appropriate."—*Science Service*

Convalescent Serum Prevents Chicken Pox and Measles. Chicken pox may be added to the list of diseases that can be prevented by vaccination.

Dr. Jean V. Cooke of the Washington University School of Medicine at St. Louis, Mo., has reported to the American College of Physicians that inoculation of exposed children with serum from convalescent patients has successfully prevented cases of both chicken pox and measles.

Though the former is sufficiently mild a disease not to require general protective measures, its appearance in epidemics in institutions causes considerable difficulty, especially in the very young children affected. Of a total of 369 cases of exposed children vaccinated for chicken pox, described in medical literature, Dr. Cooke declared only 74 or 20 per cent developed chicken pox. Of 206 unvaccinated exposed children observed as controls, 158 or 77 per cent contracted the disease. Such immunity is temporary but serves to protect orphanages and schools from the inconvenience of an epidemic.

The preventive treatment for measles, said Dr. Cooke, should be concentrated on account of the danger of complications on infants and young children under five years of age. Results with this method show, he stated, that almost 90 per cent of children given convalescents' serum during the first week after exposure fail to develop the disease.—*Science Service*

CREATING INTEREST IN FRESHMAN CHEMISTRY

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Freshman chemistry in college is never considered in student vernacular "a crip course" and is not universally chosen as an elective by students desiring easy credits. Reports from chemistry departments of various institutions give as reasons for a rather high percentage of failures: "lack of preparation," "lack of application," and "lack of interest." Very seldom is the report "lack of ability" applicable, as modern college entrance requirements are becoming more exacting and the weaker high-school students are required to better prepare themselves before entering college. Present methods of section grouping according to ability, as a result of entrance psychological tests and a careful check on high-school records, enable the college instructor to handle each section more efficiently.

The freshman course in chemistry must, therefore, be presented in such a way as to include a summary of preparatory work which is fundamental and prerequisite to the college course, to stimulate interest in the course, and thereby create a desire in the student to get the most out of his work by his own efforts.

The course in inorganic chemistry at the Agricultural and Mechanical College of Texas is required of practically all students. In view of the fact that this is a required course and would not be chosen as an elective by some students, the problem of the most efficient teaching method is a vital one. Interest must be held, determination and self-confidence of the student stimulated, and a well-balanced ratio of the theoretical to the practical maintained. In all of this the fact that the course must meet standard college requirements should be kept in mind.

Throughout the year the various sections, averaging twenty-five to thirty students each, under different instructors, follow a systematic outline of work, with lecture, recitation, and laboratory each week emphasizing the same subject-matter. The personality and ability of the instructor in leadership is here tested and on this leadership to a large extent depends successful teaching. The spirit of "come on let's do it" and not "go do it," and the development of the consciousness that "our section is the best taking the course" goes far towards obtaining successful results.

Early in the year the instructors tell their students of the Chemical Contest, and inaugurate interest in this event. The first contest at this college was conducted in May, 1923, with such enthusiastic response from student and instructor that it has become an annual event. Every student taking the course must enter the preliminary contest which is conducted by the individual instructor in each section. The high point man in each

section then enters the final contest as representative of his section. The essentials of the contest are as follows:

1. Realizing the fact that the study of chemistry should develop reasoning power and ability to apply laws and theories, and not merely develop a "dictionary brain" the contest is divided in three parts: Names and Formulas, Equations, and Problems.

2. Both preliminary and final contests are written with a definite length of time allowed for each division.

3. Preliminary contest questions are prepared and the papers graded by a committee, thereby avoiding any student criticism of favoritism.

4. For the preliminary, two recitation periods are used. During the first period are given twenty-five names to write formulas, twenty-five formulas to write names, and twenty-five equations to balance. The second period is devoted to the solution of ten general type problems.

5. Each student is given three daily grades on this work, one for each division of the contest.

6. The final contest is conducted in a similar manner but questions and grading are left to an instructor of advanced work who does not teach any freshmen.

7. Each student draws a "contest number" which is the only mark he places on the outside of the paper he submits. The teacher who conducts the contest knows only the number of the winner.

8. A list of contestants together with their numbers is placed in a sealed envelope.

9. Within a day or two after the contest the students who were representatives of the various sections are honored with a banquet by the Department of Chemistry and Chemical Engineering. Members of the department, together with the president and various deans of the college, are invited, making this a very important occasion honoring scholarship.

10. At this meeting the winner of the contest is announced by number and from the list in the sealed envelope his name is ascertained.

11. As a prize the winner is given a handbook, he choosing the one which will later be useful in his college course. Beginning this year one of the former students of the college has offered a cash prize of $25.00 to the winner of the contest.

12. Letters are written to parents of the boys representing the various sections telling them of the good work being done by their sons. Newspaper publicity is also given through the state press.

Many favorable results are noted as a result of this contest. First of all the student is given recognition for excellent scholastic work, just as the athlete receives praise for his effort. Rivalry between sections is encouraged, which, together with rivalry between instructors, makes for greater interest in the course. Students and instructors alike put

in considerable time in preparation for this contest, and the section winners are drilled overtime, by their classmates, in preparation for the final contest. Of the five contests since 1923, three have been won by electrical engineers, one by a chemical engineer, and one by a student in liberal arts and science. Many of the good men, however, have developed an interest in chemistry through these contests and have continued their work in the subject. From the standpoint of favorable publicity, the parents and taxpayers appreciate the effort being made to encourage and reward scholarship.

It is hoped that at some time these contests may become intercollegiate in a similar manner to athletic events. This will have a great tendency to equalize the standards of collegiate work in chemistry, and by contact with representatives from other institutions would inevitably react for better presentation of freshman work in this science.

THE DIVISION OF HISTORY OF CHEMISTRY

The former Section of History of Chemistry of the American Chemical Society is now a Division, and members who wish to be enrolled in this Division are invited to send their names to Dr. Tenney L. Davis, Massachusetts Institute of Technology, Cambridge, Mass.

New Vitamin Discovered: Needed by Young Trout. A new vitamin, designated as "Factor 'H'" by its discoverers, has been added to the list of these mysterious accessory food substances required for normal health and growth in animals. It is found in raw liver, and to a slight extent in dried milk, and so far as is yet known is needed only by young trout. With it they grow normally, without it they die.

The discovery was made by C. M. McCay, F. C. Bing, and W. E. Dilley of Cornell University, and will be formally announced in the forthcoming issue of *Science*. It came as the result of an effort to learn the scientific reason underlying the common practice in fish hatcheries of feeding young trout on raw liver. Groups of fingerlings were kept in isolated feeding pools, and supplied with carefully compounded rations. Some of these included various known vitamins and some of them no vitamins at all. One group received a vitamin-free diet with a certain amount of dried milk added. None of the fish got any liver at the start.

One by one all the groups of young fish died, although the ones receiving dried milk along with their food outlived the rest. Finally one group of survivors was allowed to have its normal diet of raw liver. Immediately they "picked up" and began to grow rapidly. The investigators, therefore, concluded that young trout need, for life and normal growth, something that is found in raw liver and to a less extent in dried milk, but yet is not any known vitamin.

Further experiments showed that dried and cooked liver would not have the same results as the raw meat when fed to young trout, and that a "synthetic" milk, compounded out of substances normally found in natural milk, was also unavailing to keep the little fish alive.—*Science Service*

CHEMISTRY AT NEW YORK UNIVERSITY—A RETROSPECT

WILLIAM H. NICHOLS, ALLIED CHEMICAL AND DYE CORPORATION, NEW YORK CITY

It will generally be admitted that the education of the preparatory or high-school student would be more likely to attain its greatest usefulness if he could determine for himself what he wanted to make of his life, instead of drifting towards general results. This is one of the most important decisions he will ever be called upon to make. I say "determine for himself," as he will be much more likely to succeed if his profession or occupation be agreeable to him, and he would not be likely to choose any other. Parents should take note of this almost self-evident proposition. The difficulty of getting a youth to think seriously of his future is recognized and not easily understood, but it is a general experience. Sometimes it happens that a flash of light, unsought and unexpected, shows the way. Happy is the youth who catches its meaning and follows its lead. My own experience furnishes an illustration.

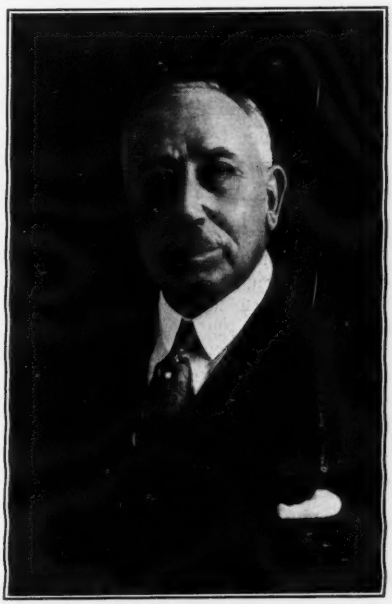
My attention was directed toward chemistry while I was a student at Brooklyn Polytechnic, when it was a prep school pure and simple. I knew but little about the subject and happened on it because it was printed in the catalog as a part of my course. At the very first lecture, the teacher, good old Prof. Geo. W. Plympton, spoke of "hydrochloric acid" and I was fascinated with the name, although I did not know what it was. The mention of that acid decided my life work. It might have been different if the professor had spoken of "muriatic acid"—another name for the same thing. I think it was the sonorous "hydrochloric" that captured my fancy. At any rate, I pitched into chemistry.

This introduction to a great subject was followed by two years of laboratory work at the Polytechnic, backed up by numerous lectures, and the study of books. The result confirmed my choice and I became more and more delighted with chemistry as time passed on. When I finished my course at the Polytechnic I had no doubt whatever as to what I was going to do in the future.

After a few months at Cornell, at the very beginning of that splendid institution, but where, unfortunately, I got no chemistry, I made up my mind that the best preparation I could make would be to select some great man and study under his supervision. After carefully considering this, I decided on Professor John W. Draper, of N. Y. U., as the most outstanding of all the chemists of that time. I entered N. Y. U. early in the year 1869 and found myself at once enjoying the lectures of the great man who had so much attracted me, assisted as he was by his two sons, Dr. John and Dr. Henry, as we called them. Dr. Draper's lectures were given at the old University Building on Washington Square and, as might have been expected, were as far advanced as knowledge of the science of

chemistry at that time permitted. More or less chemical engineering was included, but that field had not then been explored much.

Dr. Draper had a frequent visitor in the person of General W. T. Sherman, who, when he came, passed through the lecture room and went into Dr. Draper's private office. Of course, we were like other young men and formed all kinds of opinions as to the reason for General Sherman's visits. We concluded, without any reason whatever, that the matter under discussion concerned the transmutation of metals. Whatever may have been Dr. Draper's views on that subject, he certainly never told his class. I was once recounting this to Sir William Ramsay, giving him our opinion on the subject of the conversation between the two great men in the private office. Sir William's answer was "Why not?"



DR. WM. H. NICHOLS

The laboratory where I worked was in the Medical College on 26th Street. Dr. Draper himself did not often officiate there, but one of his sons was always present, and an excellent instructor named Stratford. The work at Washington Square took up the morning; the afternoon to a late hour was spent at the laboratory where, frequently, I was the only student. Chemistry in those days was not as popular a subject as it now is, which may account for the smallness of the class. This fact, however, enabled the professors to concentrate on me, and I have no doubt this was a real streak of luck. At any rate, when I received my B.S. degree in '70, I had a higher opinion of my chemical ability than I have ever had since—an experience of many better men. Before the year was out I had begun to put it at work, and have been at it ever since.

There were few chemists in those days and, as far as I can recollect, no chemical engineers, as we now understand that term. There was no place provided in New York for general meetings and discussions. One of the results of this unfortunate situation was that the members of our profession had little opportunity to widen their acquaintance beyond the

men they met in the course of their work, and in my case these were very few indeed. I, therefore, accepted with enthusiasm an invitation to attend a meeting on April 6, 1876, for the purpose of organizing the American Chemical Society. It was held in the old N. Y. U. building on Washington Square, N. Y., and was attended by thirty-six chemists, most of whom I had never met before. Of these thirty-six, only two or three are left. Dr. Chas. F. Chandler, for so many years the dean of the profession, occupied the chair. He announced with pride that a hundred or more chemists, qualified to join the Society, were living in New York or within a short radius of it. After much discussion, the Society was launched and candidates for its offices were nominated. At an adjourned meeting April 20th, this ticket was elected with slight modifications. Thus my chosen teacher, Dr. John W. Draper, became the first president of the little organization destined to become by far the largest chemical society in the world.

Dr. Draper's inaugural address was delivered November 16, 1876, in Chickering Hall, N. Y., before a large gathering. After a few congratulatory remarks, he said:

> Let us consider some of the reasons which would lead us to expect success, not only for our own, but also for other kindred societies. The field of nature is ever widening before us; the harvest is becoming more abundant and tempting, the reapers are more numerous. Each year the produce that is garnered exceeds that of the preceding. Perhaps then, you will listen without impatience for a few minutes this evening to one of the laborers who has taken part in the toil of the generation now finishing its work, who looks back not without a sentiment of pride on what that generation has done, who points out to you the duties and rewards that are awaiting you, and welcomes you to your task.

The address made a great impression and opened a wonderful prospect. Its concluding words are equally inspiring:

> Let us continue our labor unobtrusively, conscious of the integrity of our motives, conscious of the portentous change which is taking place in the thought of the world, conscious of the irresistible power which is behind us! Let us not return railing for railing, but above all, let us deliver unflinchingly to others the truths that Nature has delivered to us.
>
> The book of Nature! Shall not we chemists, and all our brother students, whether they be naturalists, astronomers, mathematicians, geologists, shall we not all humbly and earnestly read it? Nature, the mother of us all, has inscribed her unfading, her eternal record on the canopy of the skies, she has put it all around us on the platform of the earth! No man can tamper with it, no man can interpolate or falsify it for his own ends. She does not command us what to do, nor order us what to think. She only invites us to look around. For those who reject her she has in reserve no revenges, no social ostracism, no index expurgatorius, no auto da fé! To those who in purity of spirit worship in her heaven-pavilioned temple, she offers her guidance to that cloudy shrine in which Truth sits enthroned, "dark with the excess of light!" Thither are repairing, not driven by tyranny, but of their own accord, increasing crowds from all countries of the earth, conscious that whatever their dissensions of opinion may heretofore have been, in her presence they will find intellectual concord and unity.

In the early seventies of the last century, the chemistry department at N. Y. U. was certainly a simple affair, as was the case in most colleges. Since that time, under able heads, it has kept abreast of the phenomenal progress of the science.

I believe that in the future its contribution to the welfare of the world will be worthy of its great opportunities.

CHEMISTRY AT NEW YORK UNIVERSITY—THE NICHOLS CHEMISTRY BUILDING AT UNIVERSITY HEIGHTS*

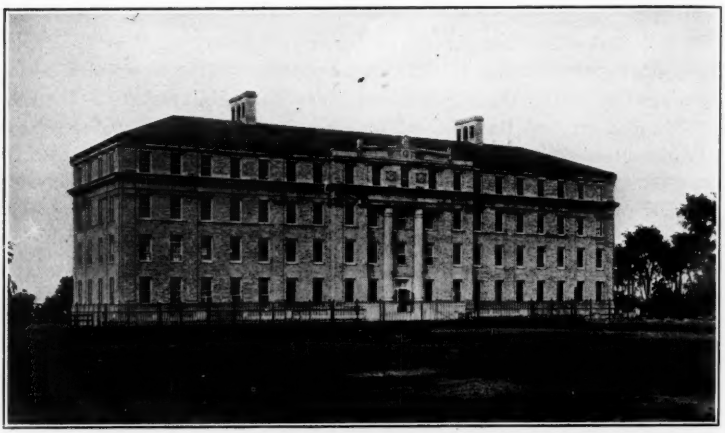
ARTHUR E. HILL, NEW YORK UNIVERSITY, NEW YORK CITY

Dr. Nichols' article has given a picture of chemistry at New York University during the seventies. It may be of interest to connect this period with preceding and succeeding decades. New York University was founded in 1831, and erected its first building for general educational purposes at Washington Square, in what is now the heart of the city. Shortly after its founding, John W. Draper came to the University in 1839 to occupy the Chair of Chemistry and Natural History; it was at this site that he conducted his well-known researches in photochemistry, including its application in the first photograph of the human face, taken in 1841. During the latter years of his lengthy service he was assisted by his sons, Henry and John C. Draper. Following his retirement in 1882, the instruction in chemistry was given first by John J. Stevenson and later by Albert Gallatin, who were succeeded by Robert W. Hall (1888) and Morris Loeb (1891), the department of natural history having been by this time divided into our modern departments. In 1894 the University removed its undergraduate colleges of Arts and of Engineering to a splendid new site of fifty acres in the north of the city, at University Heights. Here for the first time chemistry was developed to a complete curriculum in the College of Arts, and a chemical engineering course in the College of Engineering was established in 1898; a series of graduate courses was also begun at University Heights. From 1906 to 1912 the department was under the headship of Arthur B. Lamb, who did much to enlarge its activity in undergraduate and in graduate courses. In 1912 Arthur E. Hill became the head of the department.

In 1913 the University founded a new College of Arts at the original downtown site, to help in caring for the almost overpowering numbers of New York City students, and the department of chemistry was reopened at its original location in the Washington Square College in 1922. In

* This paper is based upon an address delivered by Professor Hill upon the occasion of the dedication of the Nichols Chemistry Building, December 3, 1927.

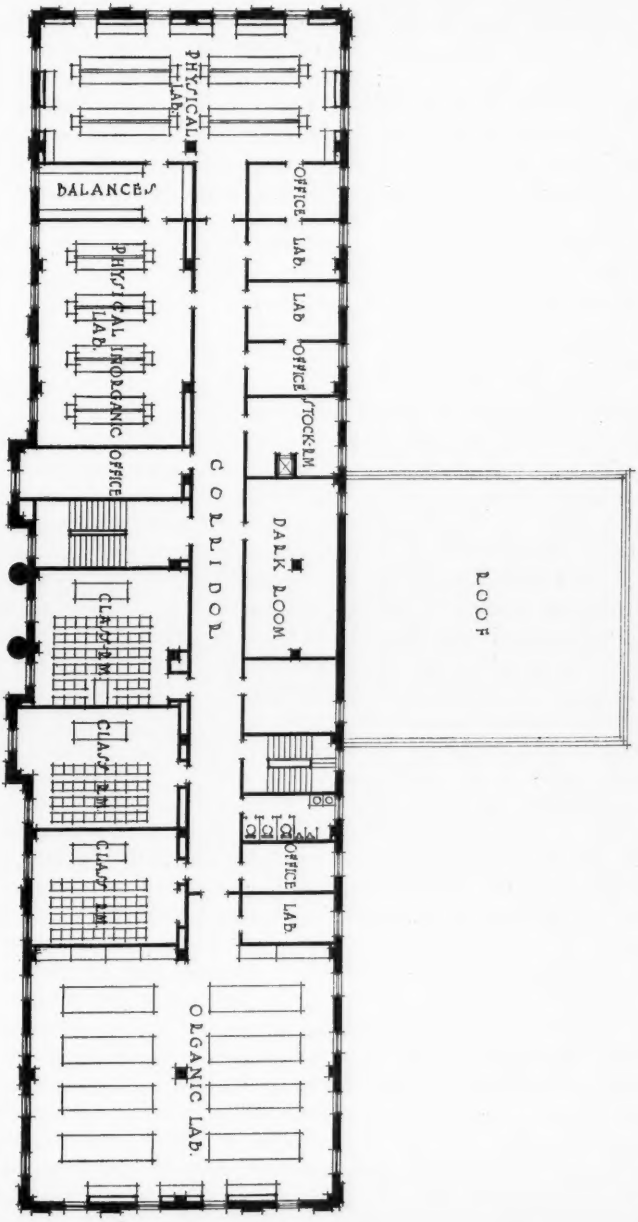
1926 James Kendall was made head of the division at this location, and in 1927 he became Dean of the Graduate School of the University. The present organization in chemistry, therefore, consists of two autonomous undergraduate faculties at the two locations, and of a single graduate faculty made up from selected teachers of both groups, the latter giving instruction interchangeably at both locations. The graduate curriculum has been enlarged to include fundamental and advanced courses in inorganic, organic, physical and analytical chemistry, and in chemical engineering, given this year to a group of sixty-two graduate students, of whom a considerable proportion are part-time assistants giving a few hours of instruction per week in the undergraduate colleges. The



THE NICHOLS CHEMISTRY BUILDING

graduate faculty for the present year is as follows: Arthur E. Hill, Raemer R. Renshaw, John P. Simmons, James Kendall, John C. Ware, Henry J. Masson, John J. Ritter, H. Austin Taylor, Eric R. Jette, Frederick W. Miller, Edgar R. Wagner, Robert E. Lutz, Ralph H. Müller, and Joseph Niederl.

A most important addition to the equipment in chemistry is the recently completed Nichols Chemistry Building, at University Heights, the gift of Dr. William H. Nichols of the class of 1870. The laboratory was completed during the past autumn and dedicated, on December 3rd, at an interesting ceremony at which Dr. Arthur B. Lamb of Harvard was the principal speaker. The exterior of the building is of modernized classical design, in accord with the general architectural scheme inaugurated at the Heights in 1894 by the late Stanford White; the architect of the build-


PHYSICAL LAB.
BALANCES
PHYSICAL LAB.
INORGANIC OFFICE
CLASS RM.
CLASS RM.
CLASS RM.
OFFICE
LAB.
LAB
OFFICE
STOCK RM.
CORRIDOR
DARK ROOM
ROOF
OFFICE
LAB.
ORGANIC LAB.

ing was Mr. Augustus N. Allen of New York City. It faces north upon Ohio Field, the athletic ground of the University, and has a frontage of 210 feet and a depth of 58 feet; in the rear of the oblong structure is an extension for the main lecture hall, so located that its height may be independent of the floor heights used in the main building. The building has four stories and a basement for general instructional uses, and an attic for the mechanical equipment; the volume is a trifle short of 1,000,000 cubic feet.

The basement of the building contains the large laboratory of chemical engineering, the laboratories of technical analysis and of electrochemistry, five research laboratories and the main stock room; the latter occupies the space beneath the lecture room, and is connected by dumb-waiter with a subsidiary stock room on each floor of the building. The main floor contains a handsome marble foyer leading to the lecture room, with cabinets for museum specimens. A second smaller laboratory for chemical engineering occupies the west end of the building, and the laboratory of inorganic chemistry the east end; the latter is arranged to take as a maximum 100 students at a time, with lockers for six sections. To avoid detail as to the building arrangements as a whole, the general system can be stated in a few words, and the accompaning diagram of the third floor taken as an example. The two ends of the building, on all floors, are used for the undergraduate laboratories, so as to make use of the maximum depth of the building; an interior hallway connects the two large rooms, leaving a series of rooms of 28 feet in depth on the one side and 17 feet in depth on the other. These are used for offices, for research laboratories, and for class-rooms.

The fourth floor is arranged to be largely free from undergraduate laboratories. It contains the Loeb Library of chemistry at one end, and the remainder is given over to a battery of research laboratories; these, with the addition of a smaller number on other floors, amount to 25 in all, the capacity ranging from 2 to 6 men per laboratory. The building as a whole has the usual equipment for draft, gas, water, air, suction, and hydrogen sulfide, and an electrical installation for direct and alternating current.

The addition of such an ample equipment should make possible an improved environment for the undergraduate courses, and also a considerable extension of graduate work and research. The research facilities of the Nichols Laboratory are open to graduate students whether located as assistants at University Heights or at Washington Square, and the graduate faculty is giving its earnest attention to an expansion in the direction of research. An increasing number of fellowships and teaching assistantships at the two locations will, it is expected, help towards that end.

CHEMISTRY AT NEW YORK UNIVERSITY—RECENT DEVELOPMENTS AT WASHINGTON SQUARE COLLEGE

WILLIAM C. MACTAVISH, NEW YORK UNIVERSITY, NEW YORK CITY

In the year 1913 there arose a demand for courses in chemistry at Washington Square College. No laboratories were available at this center of the University and to meet the situation an appeal was made to the chemistry department of the University's Medical College for the temporary use of its laboratories. The generosity of Professor John A. Mandel, the head of that department, made it possible to offer courses in inorganic and organic chemistry there. Nineteen students enrolled for the two courses, which were given by Professor A. O. Gettler and Mr. W. C. MacTavish.

In the years following, the demand for courses has steadily increased to an astonishing degree, as a glance at the chart below will show. New courses have been added and the constant increase in enrolment has called for increasingly greater space and facilities.

Year	A1-A2 Inorganic	1–2 Inorganic	5–6 Qualitative	3–4 Organic	21 Quantitative	22 Quantitative	19 Physical	16 Chem. of colloids	9 Hist. of Chem.	12 Chem. of Cell.	17 Chemical Math.	25–26 Analytical	Pre-Seminar	Household chem.	Textile chem.	Graduate course enrolments	Total	No. of staff
1914 15	...	14	3	2	...	..	..	..	..	...	..	...	..	..	..	...	19	2
1915–16	...	28	1	4	...	..	..	..	..	...	..	...	..	..	..	...	33	2
1916–17	...	23	1	5	...	..	..	..	..	...	..	...	..	.	..	...	29	2
1917–18	...	31	3	10	...	..	..	..	..	...	..	...	..	..	..	...	44	3
1918–19	...	3	0	3	...	..	..	..	..	...	..	...	..	..	..	...	6	3
1919–20	...	20	4	21	...	..	..	..	..	...	..	...	.	..	..	...	45	3
1920–21	...	180	6	17	...	..	..	..	..	...	..	...	..	..	..	...	203	4
1921–22	...	710	7	25	...	..	..	..	..	...	..	...	..	..	..	...	747	8
1922–23	...	969	61	69	5	..	..	..	..	...	..	...	..	..	..	...	1104	13
1923–24	...	1054	138	35	16	..	6	..	..	...	..	...	..	..	..	..	1239	14
1924–25	...	1068	230	107	15	..	6	..	10	13	..	...	1	..	..	...	1450	20
1925–26	...	1133	498	183	18	..	11	21	20	58	..	...	2	..	..	...	1944	30
1926–27	136	811	267	297	163	16	15	41	27	104	..	89	2	5	4	29	2006	38
1927–28	374	984	186	292	111	15	24	60	42	100	39	163	4	9	7	132	2542	59

ENROLMENT IN CHEMISTRY AT WASHINGTON SQUARE COLLEGE, NEW YORK UNIVERSITY, 1914–28

In 1922 a laboratory was built in the main building at Washington Square College and more new laboratories have been added since then from time to time. The department is now making use of three full floors of the annex building, a total of 22,853 square feet. This space is divided into six large student laboratories, 14 research laboratories, 2 dark rooms, offices and storerooms, etc.

The laboratories, both student and research, are splendidly equipped for teaching and chemical investigation. A working library of 500 volumes is situated on the new laboratory floor.

The staff has been increased from year to year and now numbers 59, ten of whom are women. In 1926 Professor Kendall, then of Columbia University, was invited to the department as Professor of Chemistry and Administrative Chairman for the particular purpose of developing graduate teaching and research. Last year he was appointed Dean of the Graduate School.

The training of the present staff is indicated by the following degrees: Ph.D., 19; M.S., 10; M.A., 7; B.Sc., 18; A.B., 4; and Indus. Eng., 1. Five members of the department received their doctorates from foreign universities—three from the University of Edinburgh, one from the University of Paris, and one from the University of Graz. Three other members of the staff have spent a year or more in European laboratories after having received a doctorate in this country.

The literary and scientific contributions of the staff are already numerous and are rapidly increasing in number. Recent books include "General Chemistry" by Professor Kendall and "Oxidation-Reduction Reactions" by Professor Jette. Among the recent journal publications from various members are:

"The Alcoholic Content of the Human Brain in Its Relation to Intoxication," *Archives of Pathology and Laboratory Medicine*, Feb., **1927,** by Alexander O. Gettler.

"Uber die Quantenempfindlichkeit der Milchsaure-Uranyl-Sulfat-Zersetzung," *Biochemisch. Zeitschrift*, **1926,** by Ralph H. Müller.

"Application of the Photo-Electric Cell to Automatic Titration" (to be published in *Industrial and Engineering Chemistry*), by H. M. Partridge with Dr. Ralph H. Müller.

"An Attempted Separation of Hafnium and Zirconium by the Ionic Migration Method," by Dr. William West (in collaboration with Professor Kendall).

"The Separation of Radium and of Mesothorium I from Barium by the Ionic Migration Method," by Dr. William West (in collaboration with Professors Kendall and Jette). Both published in the *Journal of the American Chemical Society*.

Up to 1926 the department was not very active in the graduate school of the University largely because the staff was heavily burdened with undergraduate teaching and in addition, the laboratory facilities were insufficient. The offering of graduate work now comprises all the fundamental courses and will be augmented as found necessary.

The development of the department of chemistry as outlined above has been made possible in a large part by the keen interest and good advice as well as kindly encouragement of Professor John A. Mandel, head of the department of chemistry at New York University's Medical College.

CHEMISTRY AT NEW YORK UNIVERSITY—THE FUTURE*

JAMES KENDALL, NEW YORK UNIVERSITY, NEW YORK CITY

The completion of the Nichols Chemistry Building comes at a very opportune time in the development of the Graduate School of New York University, for there can be no question that the progress of our graduate work in chemistry has been hindered in the last few years solely through lack of facilities such as the Nichols Building now amply provides.

The importance of chemistry in national defense was thoroughly recognized during the war, and the expansion of American chemical industry to a point adequate to meet any future emergency has continued steadily since. These two factors have induced a large increase in the number of students taking graduate work in chemistry throughout the country and the tide shows no signs of receding. At present nearly one-half of the Ph.D. degrees in all sciences in American Universities fall in the one field of chemistry. During the last eight years no fewer than 1661 doctorates in chemistry have been granted. Of this number New York University can claim only twenty. This is scarcely a fitting proportion for a university of its size and standing, and there can be no question that it will occupy a much more prominent position in the immediate future with the increased facilities now at its command. The registration of graduate students in chemistry in the University has increased in this one year from 32 to 62. The majority of the new students intend to proceed toward the Ph.D. degree and consequently we may anticipate an average output of 20 Ph.D.'s in chemistry per year, instead of twenty in eight years.

This striking increase in graduate work in chemistry must not be interpreted as due to any lowering of standards. Most of our graduate students are also engaged in part-time teaching in the University College of Arts and Pure Science or in the Washington Square College. They are able men and women, selected on the basis of exceptionally good undergraduate records. It may not be generally known that the combined chemistry staffs of these two Colleges represent the largest department of chemistry in the United States, and we are confident that quality has not been subordinated in any degree to quantity. The scientific output of New York University in chemistry may, therefore, be expected to rank on a par with that of any other institution in the country throughout the future, provided that adequate facilities for conducting advanced research are maintained.

Here is a point on which special emphasis must be placed. While the department of chemistry at University College has maintained a steady

* An address delivered by Dean Kendall upon the occasion of the dedication of the Nichols Chemistry Building, December 3, 1927.

growth, yet the main increase in staff and students during the past decade has been in the department at Washington Square, and it is unfortunate that the distance between the two centers is sufficiently great to prevent the graduate students of this latter college from enjoying the full benefits of the new chemistry building. What is to be done for the future needs of the graduate students at the downtown center? It would seem inadvisable to duplicate the Nichols Chemistry Building by a similar laboratory at Washington Square, even if a benevolent donor could be discovered. The University should, I feel, seek another solution which will take the greatest possible advantage of its dual location. The proximity of the Washington Square College to the chemical industries of Greater New York ought to stimulate the formation of close associations between the various chemical trades and the scientific departments of the University. A laboratory for industrial research in chemistry sponsored by those chemical industries which would be benefited most directly would put the University in a position not only to be of invaluable service to such industries, but also to round out its program of advanced work in chemistry in a logical and comprehensive manner. It is to be hoped that the great corporations of our metropolitan district will recognize the exceptional opportunity which is here open to them, and that this present example of Dr. Nichols' generosity to New York University will be emulated shortly by the coöperative support of chemical industry in general.

UNITED STATES CIVIL-SERVICE EXAMINATIONS

The United States Civil-Service Commission announces the following open competitive examinations:

Explosives Organic Chemist, $3800
Biochemist (Soil Fertility), $3800 to $5000
Associate Soil Technologist, $3000 to $3600
Assistant Soil Technologist, $2400 to $3000

Applications for these positions must be on file with the Civil-Service Commission at Washington, D. C., not later than May 8th.

Competitors will be rated on their education and experience, and publications or a thesis to be filed with the application.

Full information may be obtained from the United States Civil-Service Commission at Washington, D. C., or the secretary of the United States civil-service board of examiners at the post-office or customhouse in any city.

British Test Charcoal Driven Automobiles. The use of charcoal for producer-gas as a propellant for motor vehicles is being seriously considered in Great Britain. The Forests Products Research Laboratory has already conducted preliminary experiments on various methods of preparing charcoal for this purpose. So far two French types of portable kilns, and also the more ordinary type of bee-hive kiln have been investigated. Arrangements have been made with the Fuel Research Station to carry out tests on the charcoal prepared from various species of timber, and to determine its value for producer-gas.—*Science Service*

EFFICIENT LABORATORY INSTRUCTION IN CHEMISTRY*

HERBERT R. SMITH, LAKE VIEW HIGH SCHOOL, CHICAGO, ILLINOIS

The expense for laboratory equipment in the teaching of chemistry is greater on the average than that for any of the other sciences. The present equipment for chemistry is not adaptable for the teaching of other sciences. These two facts prevent chemistry from being offered as a study in the smaller high schools, where there are not sufficient classes to keep the equipment in use most of the school day. It is decidedly unfair to deny a student the opportunity to study chemistry in this modern age because he happens to be a member of a small school, so we wish to present a remedy for this situation and at the same time emphasize the proper function of laboratory training.

We have no theories to offer. By trial and test of experimental use during a fifteen-year period at Lake View High School we have crystallized opinions into facts or fiction and discarded the latter. We have two laboratories of standard equipment for individual pupil use but our pupils "are as sick that surfeit with too much as they that starve with nothing." Our chief objective is to train pupils to discover facts and solve problems by the scientific method, but without definite training in how to use the equipment provided, our pupils know no more than they who have none. If acquiring information is the aim, then those who depend entirely on the textbook are superior to those who have had laboratory practice, when equal periods of time are used. Then, why have the laboratory with its expense in equipment and pupils' time? *The laboratory method is the only effective way to train pupils to think and discover facts.* This is the real objective in all education but it is so easy to allow the acquiring of information to usurp its place. Where pupils have the free use of a textbook and have laboratory practice, those who rate above 80% in grade—with an only occasional exception—rely on verbal memory of what was read from the text rather than on what was experienced by actual contact with facts. The reason for this condition is soon found. Almost all pupil effort in the various subjects is directed to book-learning. They are told by the book what to believe and what to say. Their recitations are repetitions of phrases from the book. Few and far between are the cases where they have of their own initiative or have been required to consider evidence as a basis for deriving beliefs or judgments. When pupils come to experimental practice they see the results as the book described them, and not as they observed them. Experience is continually discounted by what they read. Do you college professors expect to find research workers among high-

* Paper read before the Division of Chemical Education at the 74th meeting of the American Chemical Society at Detroit, Mich., September 7, 1927.

school pupils so misguided? Is there anything that can justify such anti-scientific procedure?

We find the average textbook in chemistry of more detriment than value in realizing our objective of training pupils to think. There is little in it that requires thinking of the pupil and most of them even tell all the properties of substances so there is nothing to observe in the experimental work. With textbooks so constituted we may state the laboratory objective as: a method of disposing of chemicals without value received.

An evidence of improvement is to be found in some recent textbooks that do not tell the pupils what they can learn by their own observation. It is a pleasure to know that there are teachers who believe that their pupils are able and willing to work out their education in preference to having it furnished to them "ready-made." At Lake View we have discontinued the use of textbooks as they are now constituted, and have prepared directions for the experimental study of chemistry in project form. In these we make clear what the scientific method is and its value. Pupils are trained to practice it as a means of acquiring information from facts without personal bias, and as a means of solving the problems of life in any field.

The banishing of the textbook leaves the pupil literally "at sea without a compass," when introduced to laboratory practice without special training. The other science subjects studied previous to chemistry have given the pupils little or no knowledge of the scientific method. Those who succeed at the start by the laboratory method do so from inherent ability rather than from training. Hence an initial period of training in how to study by the experimental method is necessary. Without this training the result of laboratory work is the same either in case of using a text or doing without. *Nothing of value is learned.* The only difference is that with a textbook the instructor thinks the pupils are learning; without it he has no such illusion. He knows they are not. Of these two alternatives good pedagogy would choose the latter as the lesser of the two evils.

The manner of training for laboratory work was reported to this division at the Philadelphia meeting last year,[1] as the Lake View Group Method. Briefly summarized it is as follows: After a short period of general training each class is divided into two groups on the basis of effective work. Those who are effective (10 to 30% depending on the class) work individually and compose group A. The others, group B, are those who cannot or will not learn effectively by the laboratory method under their own management. Two of this group direct the experimental work with the others around as observers. The instructor gives his whole time to questioning, emphasizing fundamentals, and preserving a student attitude towards

[1] THIS JOURNAL, **3**, 307–12 (March, 1926); and **4**, 359–63 (March, 1927).

the work. Each one makes a neat written record of the work. The tests the following day show mastery of work equal to that of the group A. After another year's careful testing of this plan we are able to state the following conclusions, regarding the values of this method, with some degree of certainty.

1. The students in group B, most in need of mental exercise, receive it. They are told answers only after an effort on their part.

2. The instructor has an intimate knowledge of each pupil's effort. No copying, no dishonesty.

3. Close supervision by the instructor is necessary for an increasing number of pupils who have few disciplinary factors in their previous training.

4. Understanding of fundamentals is thorough. The records of results are accurate and complete. All that remains is the entry of credit by the instructor. No errors to correct and laboriously explain to various pupils.

5. As pupils become proficient they are allowed to study under their own direction in group A, which is a definite incentive to effort and independence. Those of group A who show lack of effort are transferred to group B.

6. Less material and equipment are needed under the group plan. There is no good reason for any school to omit chemistry because of expense or because of not having a fully equipped laboratory. The apparatus and materials for all desirable individual experiments are inexpensive. In all others what would suffice for one person is sufficient for the group. Chemistry can be effectively taught with as little expense as any science. Efficiency is determined by the use of the equipment and not necessarily by the quantity of it.

Booze No Use as Sex Ratio Control. Alcohol as a means of determining the ratio of sons to daughters among experimental animals, and therefore presumably among human beings also, is a completely negative quantity. Even in heavy and repeated doses it has no effect; and earlier experiments which seemed to indicate the contrary have to be dismissed as inadequately planned or improperly interpreted.

This is the conclusion reached by Dr. E. C. MacDowell, of the department of Genetics, Carnegie Institution of Washington. Dr. MacDowell tested the hypothesis that alcohol will produce more male than female offspring in three different ways. He subjected male mice to alcohol fumes until, in vulgar parlance, they "passed out" completely, and used these as fathers of experimental litters mothered by normal females. Then he reversed the procedure, normal male mice begetting offspring from alcoholic mothers. Finally, he tried injecting liquid alcohol under the skins of other male mice. In each case he mated the normal animals first with alcoholics and then with normals of opposite sex, and in all the experiments used large numbers of animals, in order to do away with statistical errors.

When all these precautions were taken, he found that alcoholic mice of either sex produced male and female offspring in approximately equal numbers, just as all normal animals do.—*Science Service*

THE ORGANIZATION AND RESEARCHES IN PROGRESS AT THE KAISER WILHELM INSTITUTE FOR PHYSICAL AND ELECTROCHEMISTRY

L. H. REVERSON,[1] KAISER WILHELM INSTITUTE, BERLIN-DAHLEM, GERMANY

The Kaiser Wilhelm Institute for physical and electrochemistry opened on the nineteenth of September for the Winter Semester. The Winter Semester ends at the Easter vacation. Following Easter the Summer Semester begins and this closes on the first of August. The Institute is located in Dahlem, one of the suburbs of Berlin, and is one of several Kaiser Wilhelm Institutes under the direction of the Kaiser Wilhelm Gesellschaft zur Förderung der Wissenschaften. The laboratories of the Institute are as well equipped for physicochemical research as any in Germany but they are still suffering from lack of funds for new equipment. There are at present fifty research workers carrying on scientific investigations at the Institute. Professor Fritz Haber is its Director and Professor Herbert Freundlich is the Associate Director.

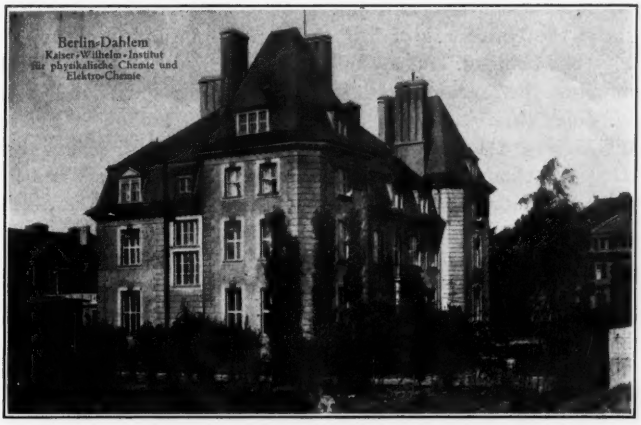
In so far as the research work and research personnel is concerned the Institute is divided into two sections, one section is under the direction of Professor Haber, while the other is directed by Professor Freundlich. Professor Haber has under his direction three assistants, namely: Doctors Bonhoeffer, Kallman, and Matthias. Professor Freundlich also has three assistants. They are Doctors Zocher, Kantzky, and Ettisch. In addition there are two Fellows of the Institute, Professors Ladenburg and Polanyi. Each of these assistants and fellows has several investigators working under his direction and many of these are candidates for the doctorate. The Institute has a pleasant arrangement with the University of Berlin whereby candidates may carry on their investigations at the Institute and present these researches as dissertations for the doctor's degree at the University.

A great variety of problems is being investigated in the Institute at the present time. These researches range from investigations in pure physics to those in which physical chemistry is applied to biological problems. It will, therefore, be best to enumerate the particular types of research in progress. Professor Haber is personally directing researches in catalytic oxidation. Dr. Matthias is at work, under his direction, completing the studies on the transmutation of the elements. In this work only negative results have been obtained. Professor Ladenburg and his co-workers are engaged in study in the field of pure physics. He is at present investigating anomalous dispersion in the spectra of gases. Professor Polanyi and his collaborators are at present studying the chemiluminescence produced by the reactions of gases. They are also engaged

[1] Fellow of the John Simon Guggenheim Memorial Foundation 1927–1928, on leave from the University of Minnesota, Minneapolis, Minnesota.

in researches on the adsorption of vapors from the thermodynamic point of view. At the same time Professor Polanyi is developing a method for the production of colloidal dispersions at the temperature of liquid air. Dr. Bonhoeffer and his colleagues are continuing to investigate the properties of active nitrogen and active hydrogen. Dr. Kallman is at present studying the nature of the products which result when electrons collide with gas molecules. A mass spectrograph is being used in this work.

The section of the Institute which is under the direction of Professor Freundlich is chiefly concerned with researches in the field of colloid chemistry. He is personally directing researches on coagulation, adsorption, the colloidal properties of latex, and thixotropy. Thixotropy is that phe-



THE KAISER WILHELM INSTITUTE AT BERLIN

nomenon exhibited by concentrated colloidal solutions, of setting to gels which became fluid sols once more on shaking or on treatment by other mechanical means. Dr. Zocher and his co-workers are busily studying liquid crystals and sols with non-globular particles. These investigations are chiefly of an optical character. Dr. Kantzky and those associated with him are investigating chemiluminescence with special reference to surface reactions. They are also studying the colloidal behavior of the derivatives of calcium silicide. Dr. Ettisch and his collaborators are carrying colloid research into the field of physiology and they are also studying electrodialysis.

In addition to the researches in progress the Institute holds a Colloquium every other Monday afternoon. Here the researches of the Institute are presented and discussed. Many helpful criticisms come out in

these meetings and much progress results. Members of the staff often give courses of lectures in the Institute as well as at the University of Berlin. This gives plenty of opportunity for the students to hear the latest developments in science.

It is evident from the above description that the Institute is investigating a great variety of problems. It may also be seen that the Institute is well-balanced. A given investigator has available the suggestions and ideas of men in widely differing fields of research. The character and number of publications coming from the Institute every year gives ample evidence of the efficiency of the organization.

It may be of interest to note that five Americans are at present pursuing investigations in the Institute. Three of these are Fellows of the John Simon Guggenheim Memorial Foundation. They are Professor Richard Bradfield of the University of Missouri, Professor Louis Heilbrun of the University of Michigan, and myself. The others are Mr. H. O. Albrecht who came from the Massachusetts Institute of Technology, and Dr. Harold Abramson of Columbia University who has been holding a Fellowship in Medicine from the National Research Council. Mr. Albrecht is investigating the chemiluminescence of certain organic substances for his doctorate. His home is in St. Paul, Minnesota. Dr. Abramson has been studying the electrophoresis of white blood cells and inert particles in dilute protein sols and protein gels. He has been applying this information to the physicochemical mechanism of the inflammatory process. The Americans find themselves very pleasantly situated at the Institute and they are shown every consideration.

Mysterious Sun Element Believed Common Air Gas. Coronium, the mysterious substance in the sun's corona that only manifests itself in spectrum photographs made at the time of a total solar eclipse, is probably due to argon, third most abundant gas in the air. This has been found by researches carried on at the Ryerson Physical Laboratory of the University of Chicago by Dr. Ira M. Freeman.

"Coronium" was first found in 1869 when, in the eclipse of that year, astronomers noticed a strange line of a green color in the spectrum of the corona. This is the extremely rarefied outer layer of the sun that is visible only when the central disc of the sun is obscured by the moon. Ever since that time physicists have been trying to find the cause of it and a group of unknown lines that were later discovered.

Dr. Freeman has found that 18 of these lines can be identified as those of the element argon, which occupies nearly one per cent of the atmosphere. Other observations of the sun with the aid of the spectroscope have never shown the presence of argon, but Dr. Freeman points out, it may well be that it is present but that it is quite possible the conditions on the sun are not just right for it to be in evidence ordinarily.—*Science Service*

A QUESTION OF PROCEDURE

CHARLES H. STONE, ENGLISH HIGH SCHOOL, BOSTON, MASSACHUSETTS

In the solution of a series of related mathematical problems it would appear that the best method is one which is simple, logical, and capable of application to any variations of such problems.

If one is teaching a class in percentage, one might assign such a problem as this: "Mr. B. withdrew from his savings account the sum of \$36 which was 9% of his total deposit. How much did he have in the bank before the withdrawal?" If Johnny divides 9 by 36 his procedure and reasoning are wrong. One would expect him to reason that if \$36 is 9%, 1% can be found by dividing 36 by 9 and 100%, the total or base of the problem, is to be found by multiplying the result thus obtained by 100, which gives 400. Therefore, Mr. B. had \$400 in the bank before his withdrawal.

Take another illustration. "The atomic weight of sodium is 23. A certain compound contains 43.4% of sodium. What are some possible molecular weights of the compound?" Reasoning as before, we divide 23 by 43.4 and multiply the result by 100 which gives approximately 53. If the compound contains a single sodium atom per molecule, this is the molecular weight: if the compound contains two sodium atoms per molecule, the molecular weight is 53×2 or 106, etc. The principle involved is that the base is found by dividing the percentage by the rate.

But now consider this problem: "Find the formula of a compound containing sodium 43.4%, carbon 11.3%, and oxygen 45.3%." Our textbook tells us that we are to divide each percentage by its respective atomic weight to get the ratios in which the atoms of the different atoms are present. But this procedure is directly opposite to that which Johnny has used in every preceding problem involving rate and percentage. Is it necessary thus to proceed contrary to the reasoning which he has been accustomed to follow? No, it isn't.

Proceeding just as shown in paragraph three of this article we find the molecular weight to be 53 or some multiple of 53. From this we get:

$$53 \times 0.434 = 23 = 1\text{Na}$$
$$53 \times 0.113 = 6 = \tfrac{1}{2}\text{C}$$
$$53 \times 0.453 = 24 = \tfrac{3}{2}\text{O}$$

Since we cannot have halves of atoms it is evident that we must multiply our result by two which gives 2Na, 1C, and 3O or Na_2CO_3.

If we start with carbon instead of sodium the result is the same. $(12 \div 11.3) \times 100 = 106$, the molecular weight if one carbon atom is present. From this we get:

$$106 \times 0.434 = 46 = 2\text{Na}$$
$$106 \times 0.113 = 12 = 1\text{C} \qquad \text{or } Na_2CO_3.$$
$$106 \times 0.453 = 48 = 3\text{O}$$

If we begin with oxygen we get a possible molecular weight of 35.3. Proceeding from this as illustrated above we get $^2/_3$Na, $^1/_3$C, and 1O. Since thirds of atoms are impossible we must multiply our result by three which gives the same formula obtained in the other two cases.

It appears, therefore, that without abandoning the reasoning and procedure to which pupils have been accustomed in previous work in percentage we may derive the formula of the compound by the use of any one of the percentages given in the problem.

The writer knows of no text which presents this method. All texts are unanimous in giving the method of dividing the percentages by the related atomic weights to get the ratios of the numbers of atoms; these ratios often do not come out as whole numbers but must be divided by the smallest one of the ratios to reduce the values to whole numbers. But to divide percentage by percentage is contrary to the rules of arithmetic as the pupil has been accustomed to think of it. Why, then, puzzle Johnny by giving him a new method for doing problems when methods already familiar will do the same work satisfactorily?

To thinking teachers the question is submitted whether in the writing of chemistry texts there is anything gained by abandoning the line of reasoning and procedure which has been used in all other problems involving percentage for a method which is no simpler, gives no different answer, and is neither necessary nor more logical.

Synthetic "Perfect" Diet Gives New Vitamin Clue. The day when we will live on synthetic concentrated pills of food is yet far distant. Yet science's latest attempts to raise laboratory animals on an artificially devised diet of pure foods have led to the discovery of the new vitamin F, recently announced by Dr. Herbert M. Evans of the University of California.

When a diet of purified food elements consisting of casein and recrystallized cane sugar, certain necessary salts, and the five recognized vitamins, A, B, C, D, and E, was fed to rats in the laboratories of the department of anatomy, the animals failed to reach more than half size. Theoretically, this diet contained all the elements necessary for the health and happiness of rats, but actually something else was necessary. Growth stopped altogether and the animals remained sexually immature. Natural food had to be resorted to, to supplement what might be called a chemically pure menu in order to reawaken their growth and convert them into healthy adult animals.

"Among the natural foods, lettuce and liver were the most potent," declared Dr. Evans, "and they, therefore, almost certainly contain a new sixth member of the vitamins, to which designation F will be given."

Lettuce when heated and dried failed to give the good results of the fresh product, the investigation showed.

Dr. Evans has to his credit also, the discovery of vitamin E, at one time known as vitamin X, a lack of which brings about sterility. Oil from the germ of the wheat grain is thus far the most potent source of this necessary food factor.—*Science Service*

THE STREET OF THE ALCHEMISTS

HARRY N. HOLMES, OBERLIN COLLEGE, OBERLIN, OHIO

In March, 1926, I made a brief visit to Prague in order to get a glimpse of the famous medieval architecture. The architecture was well worth a visit, but, thanks to a professor of botany in the old Czech University, my most vivid memory is of a chemical nature.

My friend, the professor, took me up on the hill overlooking the city, to see the Hradcany, or royal castle. Close against the back of the castle he showed me "Gold Street," very narrow, but too neat and clean to be

THE STREET OF THE ALCHEMISTS

called an alley. At first glimpse it seemed to me nothing but a little old street of dolls' houses, but the professor informed me that into this street King Rudolph of Bohemia gathered the alchemists of Europe under his protection. Not only did King Rudolph subsidize these alchemists to turn base metal into gold, but he actually worked with them at times, like the merry old soul he was.

By means of a smile and a language that I knew not, my friend secured us entré into one of these dolls' houses. Our hostess showed us the very forge in which the alchemist had melted lead and other base metals. She pointed to the second floor, and we crawled up, rather than walked, because of very limited head room. Things were left very much as they had been centuries ago, but everything was spotlessly clean. Tantalizing

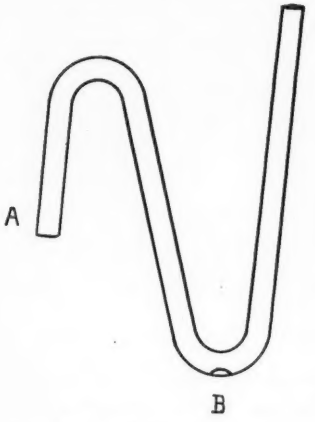
odors from the kitchen tempted us to stay, but it was evident that the dimensions of the house were not arranged for guests.

After my return to America it occurred to me that the professor of botany might get me a picture for the JOURNAL OF CHEMICAL EDUCATION. Here it is. I was astonished to find that not one of the many chemists in Europe and America to whom I told this story knew anything about "Gold Street." For that matter, neither did I find any chemists outside of France who had seen the excellent statue of Lavoisier located just behind the Madeleine in Paris. I didn't know of it either, until my wife dug up the information and led me to the shrine.

SUGGESTION FOR SIPHONING DISTASTEFUL LIQUIDS

ELBERT C. WEAVER, BULKELEY HIGH SCHOOL, HARTFORD, CONNECTICUT

For siphoning distasteful liquids, the following device is in use in our laboratory. A piece of ordinary soft glass tubing is bent in the shape of a distorted S. A hole is melted through the lower loop by means of a small flame, and the ends fire-polished as shown in the diagram.



To start the siphon (*A B*) place the finger over the hole at *B*, *A* in the liquid to be siphoned, and suck in at *C* with the mouth or a suction pump until the liquid reaches *B* when the finger is removed.

This device offers a quick and convenient method for science teachers to start a demonstration siphon on the lecture table when teaching that principle.

A household application may be made easily. The use of this device will enable one to neatly remove the cream from a bottle of milk. The necessary adjustment of the length of the leg *A* may be made by an elastic band across the loop above it. For this purpose 8 or 10 mm. tubing is a convenient size.

Belgium to Support Scientific Research. Belgium, taking advantage of its industrial prosperity, is raising a 200,000,000 franc fund ($5,600,000) for the promotion of scientific research along mechanical and chemical lines, according to information received by the U. S. Department of Commerce. The fund will be administered by the government.—*Science Service*

NEW APPARATUS FOR BOILING-POINT DETERMINATIONS

W. SWIETOSLAWSKI, POLYTECHNIC SCHOOL, WARSAW, POLAND

The works of Cottrell[1] and Washburn[2] established the basis for the design of a new boiling-point determination apparatus,[3] capable of a high degree of accuracy.

In the Cottrell boiling-point apparatus the thermometer is placed in the vapor above the liquid and not in the boiling liquid. The boiling liquid only incidentally wets the bulb of the thermometer. Washburn improved the Cottrell apparatus, but his modification remained still too complicated.

In the course of attempting a simplification of the Washburn apparatus the author conceived the idea which led to a material change in construction and to a considerable improvement in accuracy. This work was carried out two years ago at the Laboratory of Physical Chemistry of the Polytechnic School in Warsaw[4] and rendered it possible to find a series of quite new applications of the apparatus for boiling-point determinations in investigations in physical chemistry.

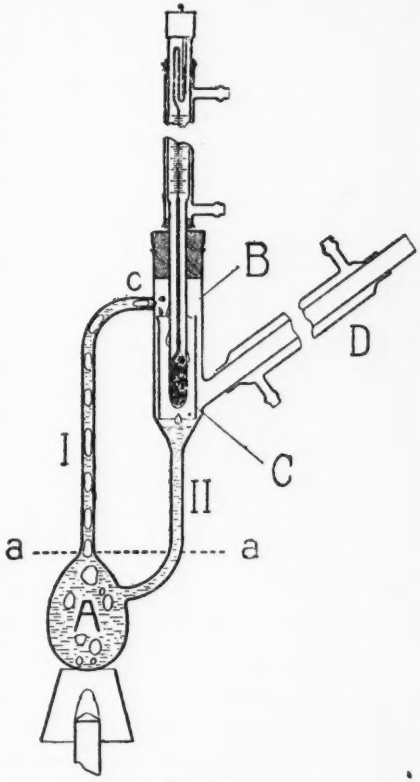


FIGURE 1

Figure 1 illustrates the most simple type of the new boiling-point apparatus. It consists of a pyrex-glass bulb A, connected by means of the tubes I and II with the part B. The thermometer is placed in B. The apparatus operates in the following

[1] F. G. Cottrell, *J. Amer. Chem. Soc.*, **41**, 721 (1919).

[2] E. W. Washburn, *Ibid.*, **41**, 729 (1919).

[3] W. Swietoslawski and W. Romer, *Bull. Acad. Sci. Polonaise* (A), **1924**, p. 59; *Roczniki Chem.*, **5**, 96 (1925).

[4] W. Swietoslawski, *Roczniki Chem.*, **7**, 30 (1927); *Bull. soc. chim.* [4] **41**, 717 (1927).

manner. The boiling liquid in the bulb *A* is carried upward through the tube I by the vapor bubbles and thrown out on the thermometer bulb. As soon as thermal equilibrium is reached the thermometer shows the exact boiling point of the liquid. The vapor condenses in the condenser *D* and flows downward through the tube II into the bulb *A*. The inside surface of this bulb is especially activated[5] in order to ensure quiet boiling and to prevent the superheating of the liquid.

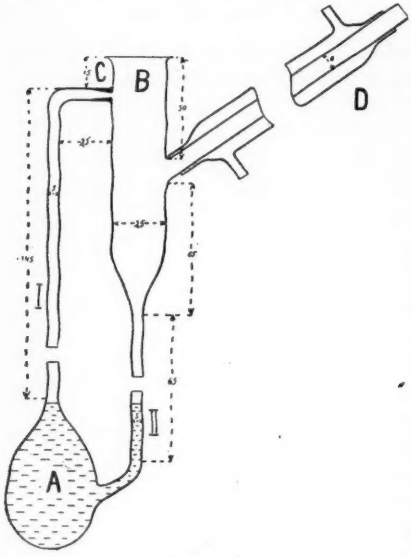


FIGURE 2

Figure 2 represents the apparatus constructed for student experiments. It is composed of two separate parts connected by means of rubber tubes in order to facilitate the replacement of broken parts. The manipulation of this presents no difficulties.

The two pieces of apparatus above described possess a common weakness, which is that the thermometer is inserted through a cork. It is possible for the boiling liquid to extract some of the cork and thus become contaminated.

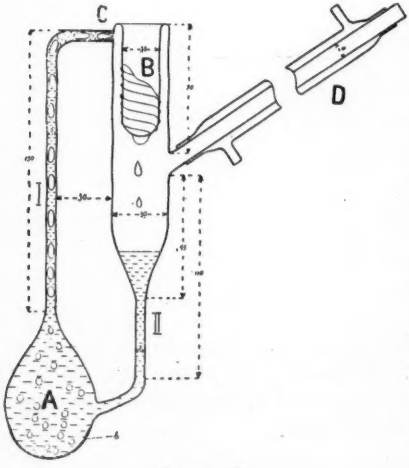


FIGURE 3

This defect is eliminated in the construction shown in Figure 3. The cork is replaced by test glass sealed into the upper edge of the part *B*. A glass spiral is sealed on the outside surface of the test glass to ensure a regular flow of liquid. Into this test glass mercury is poured and a Beckmann thermometer inserted.

A further modification of the apparatus is illustrated in Figure 4. In

[5] W. Daniewski, *Roczniki Chem.*, **7** (1927).

this construction the condenser is attached a little higher on the apparatus and the tube *F* is added. The condensed vapor flows from the condenser directly to the bulb *A* without passing through the part *B*. The side-tube *E* is added to facilitate the filling of the apparatus and obviates the necessity of removing it from its support.

It goes without saying that, in the case of very precise determinations, the entire thermometer column should be maintained at constant temperature. For this reason a glass jacket surrounds the upper part of the thermometer and constant temperature is maintained by means of a stream of water. (See Fig. 1.)

The best test of the sensitivity of the boiling-point apparatus is the variation of boiling point with change of atmospheric pressure. The apparatus should respond to the smallest changes in pressure regardless of whether a pure liquid, a mixture, or a solution is being employed. For example, it is easy to detect the difference in the boiling temperature caused by removing the apparatus from the level of the laboratory table to that of the floor. The difference in levels is in this case about 1 meter and the thermometer shows an increase of about 0.003–0.004°C. in the boiling temperature.

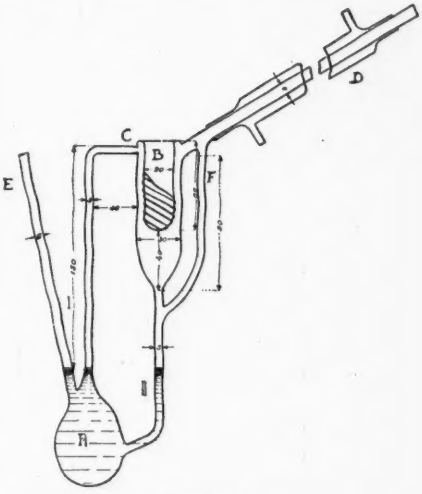


FIGURE 4

The boiling-point apparatus in the Meteorological Observatory at Warsaw exhibits quite regular dependence of the boiling temperature upon the atmospheric pressure. In the Laboratory of Physical Chemistry of the Polytechnic School at Warsaw the atmospheric pressure is measured solely by means of the boiling-point apparatus with an accuracy corresponding to ± 0.03 mm. of Hg—a degree of accuracy impossible of attainment with the ordinary mercury barometer by reason of its inertia. In this apparatus pure water is employed as the liquid.

The newest modification, devised during the past year, is the differential boiling-point apparatus shown in Figure 5. The principle employed is the same as in previous modifications. The boiling liquid is carried up through the tube *C* by the vapor and is thrown out on the test glass, *H*,

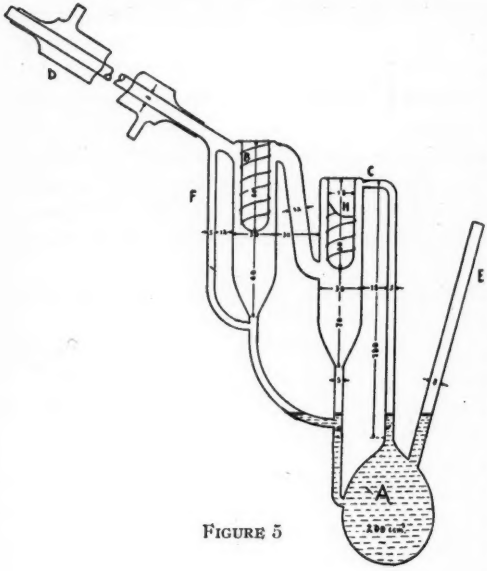


FIGURE 5

where the first thermometer is inserted. Here, as before, the temperature of the solution under investigation is measured. Pure vapor passes through the curved tube at the left to the part *B* and heats the second test glass and thermometer to the boiling temperature of the pure solvent. Farther on the vapor condenses in the condenser and flows back through the side tubes to the reservoir, *A*. Thus in this apparatus it is possible to determine simultaneously the boiling temperatures of the solution and of the pure solvent.

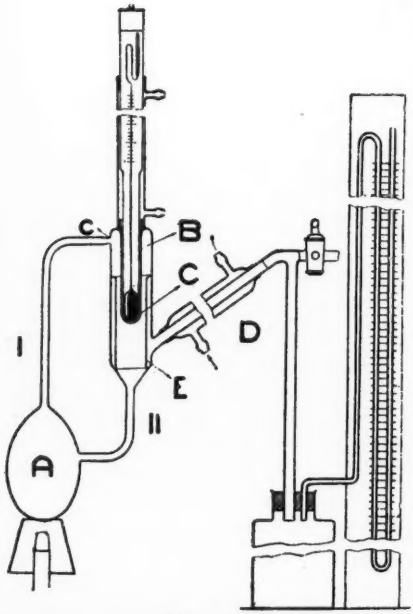


FIGURE 6

The applications of all the above-described forms are manifold. Besides determinations of boiling points, which can be made with greater accuracy than by means of any other known apparatus (the accuracy reaches ±0.0015° ±0.002°C.), it is easy to make tonometric determinations using the boiling-point apparatus joined with a manometer and manostat as in Figure 6. The same arrangement can be used for checking a thermometer and for determining the value of one degree. Especially simple is the calibration of one thermometer against another in

(*Concluded on page 475*)

POTASSIUM FERROCYANIDE AS A QUALITATIVE TEST FOR ZINC

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GROVE CITY, PENNSYLVANIA

In the literature there are occasional references to the use of potassium ferrocyanide as a qualitative test for zinc, but the use of this test has not become as general as its desirability warrants. Ganassini[1] mentions this test. Werner[2] precipitated zinc with the ferrocyanide, and then treated the precipitate with bromine water, whereupon a deep yellow color forms which is characteristic of zinc under the conditions of the experiment. Feigl and Stern[3] utilized this test for a spot reaction on black paper as a micro test for zinc. Huffered[4] tests zinc by both the sulfide and ferrocyanide tests. More recently a brief article by Mehlig[5] has shown that the potassium ferrocyanide test in the hands of student analysts leads to a greater percentage of correct reports for zinc than do the older tests. At the time our experiments were being made we were unaware of this latter paper, but it seems desirable to present our results in view of the excellence of the test and because we have examined its limitations and somewhat modified its application.

Method of Applying the Test

The filtrate from the sodium hydroxide-sodium peroxide separation is acidified and aluminum precipitated as usual. The filtrate, containing the zinc and chromium as chromate, at this point has a volume of 60 to 80 cc. in the procedure used in this laboratory. The solution is neutralized, and then 2 to 4 cc. of 6 *N* acetic acid are added, and the resulting solution is allowed to stand for 10 to 15 minutes to permit the precipitation of silica if present. Any silica is filtered off and the solution is divided into two equal parts. To one part, 1 cc. of normal potassium ferrocyanide is added. The usual amounts of zinc give a flocculent precipitate immediately, but smaller amounts give a turbidity which may take 5 to 10 minutes to form. The portion tested is compared with the untested portion to detect a turbidity, by holding the beakers between the eye and a strong light source. A turbidity in both beakers indicates incomplete removal of silica before the test was applied. The reference portion of the original solution is then tested for chromate ion in the usual manner.

[1] Ganassini, *Soc. med. chir. Pavia sedut.*, Jan. 29, **1909**; *C. A.*, **4**, 2246 (1910).
[2] F. F. Werner, *Z. anal. Chem.*, **51**, 481 (1912).
[3] Feigl and Stern, *Z. anal. Chem.*, **60**, 1 (1921).
[4] Huffered, *Proc. Indiana Acad. Sci.*, **36**, 183 (1926).
[5] J. P. Mehlig, THIS JOURNAL, **4**, 722 (June, 1927).

Sensitivity of the Test

Using solutions containing zinc chloride prepared from zinc carbonate it is possible to detect 1 mg. of zinc very readily while the limit of the sensitivity seems to be about 0.2 mg. of zinc in 80 cc. of solution, or one part in 400,000.

TABLE I

Mg. of zinc	Nature of ppt.	Time of appearance
5.0	Turbid	1 min.
3.0	Turbid	2 min.
1.0	Turbid	3 min.
0.8	Turbid	4 min.
0.6	Turbid	5 min.
0.4	Slight turbidity	20 min.
0.2	Faint turbidity	20 min.

The presence of 120 milliequivalents of acetic acid does not interfere with, although it modifies, the results of the test. In the presence of much acid, small amounts of zinc produce a turbidity with the ferrocyanide very much more quickly than without the acid, but the intensity of the turbidity so produced is very much less than that which appears when the acid is absent. This effect[6] is, no doubt, due to the two salts $Zn_2Fe(CN)_6$ and $K_2Zn_3[Fe(CN)_6]_2$. The presence of NH_4OH, however, rapidly decreases the sensitivity of the test due to the formation of the complex zinc ion.

Amounts of aluminum up to 500 mg. give no precipitate with the ferrocyanide in two hours, but on long standing a jelly may form which is colored blue due to decomposition of the ferrocyanide ion. A solution of ferrocyanide which is increasingly acid, of course, will, by atmospheric oxidation, give enough ferric ion to result in the appearance of a blue color by reaction with the ferrocyanide. Less than 10 mg. of chromic ion gives no precipitate with the reagent in half an hour. The presence of these amounts of aluminum or chromic ion, moreover, does not prevent the immediate detection of one milligram of zinc. In any case such amounts of aluminum and chromic ions cannot be present at the stage of the analysis at which the test for zinc is made.

One milligram of zinc is readily detected in the presence of 750 mg. of chromium as chromate or dichromate ion, and the dark orange color offers no hindrance to the detection of a turbidity. With larger amounts of zinc in the presence of this much chromium as chromate, but in the absence of acid zinc chromate may form, thus obscuring the test. The amount of acid specified, when added, however, does not permit zinc chromate to precipitate. It is possible, therefore, to detect 500 mg. of

[6] Mahin, "Quantitative Analysis," McGraw-Hill Book Co., **1924**, p. 251.

zinc in the presence of 500 mg. of chromium present as chromate or dichromate ion.

While the students in this laboratory have not shown as high a percentage of correctness as Mehlig[7] reports, our results on the old and new tests are of the same order as he mentions. The number of students reporting zinc present when it was not present in an unknown has decreased materially with the new test. Students have had no difficulty in detecting one milligram of zinc in the presence of 50 milligrams of three or four other metals.

Summary

1. The use of potassium ferrocyanide as a qualitative test for zinc has been described. The test is shown to be sensitive to the extent of $2^1/_2$ milligrams in one liter.

2. Aluminum and chromate ions do not interfere, and small and large amounts of zinc are readily detected in the presence of large amounts of chromium as chromate or dichromate.

3. The test is applied at the proper point in the usual qualitative scheme of analysis and, as previously shown by Mehlig, is readily adapted to student use.

[7] Mehlig, *loc. cit.*

(*Continued from p. 472*)

the differential boiling-point apparatus (Fig. 5) filled with pure liquid. There are many other applications of the boiling-point apparatus itself or in connection with more or less complicated additional apparatus. Within the limits of the present paper it is possible merely to mention a few of them as follows:[6] the determination of the exact boiling temperatures of pure liquids and solutions: the determination of the characteristic coefficient dp/dT for liquids and the calculation of the latent heat of vaporization;[7] the determination of the constant of equilibrium of chemical reactions and of the constant of velocity of reactions; boiling-point determinations under high pressures; the investigation of the coefficient of solubility of different substances in connection with changes of temperature; an application for a precise thermostat even for high temperatures.

All these applications were or are being perfected in the Laboratory of Physical Chemistry of the Polytechnic School at Warsaw.

[6] The applications of the boiling-point apparatus are described more fully in the Transactions of the Scientific Meeting of the 8th International Conference of Pure and Applied Chemistry in Warsaw, September, 1927.

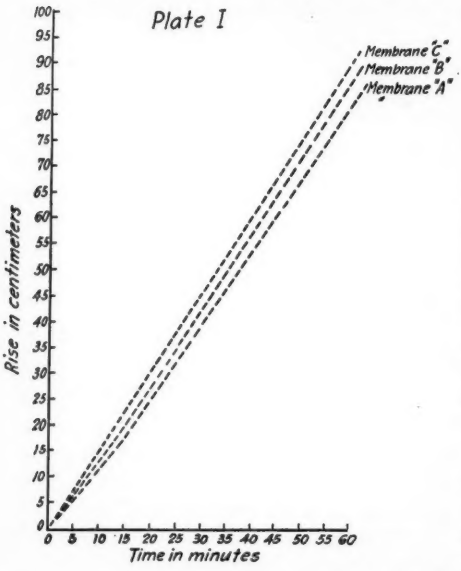
[7] The determination of the coefficient dp/dT of the liquid by means of the boiling-point apparatus and the calculation of the latent heat of vaporization has been introduced by the author as one of the experiments for students in the Laboratory of Physical Chemistry of the Polytechnic School at Warsaw.

LECTURE-TABLE DEMONSTRATION OF OSMOTIC PRESSURE

J. W. RAMSEY AND R. N. MAXSON, UNIVERSITY OF KENTUCKY, LEXINGTON, KENTUCKY

Several methods have been used to demonstrate osmotic pressure, many of which frequently fail to give convincing results in the period of the lecture. Chapin ("Exercises in Second Year Chemistry") describes an excellent experiment using a dialyzing thimble with a solution of sugar which shows a rise of one-half centimeter per minute in a tube with an internal diameter of one millimeter.

The apparatus described in this paper is perfectly dependable, easy to prepare, and will, under proper conditions, show a rise of one and one-half centimeters per minute.



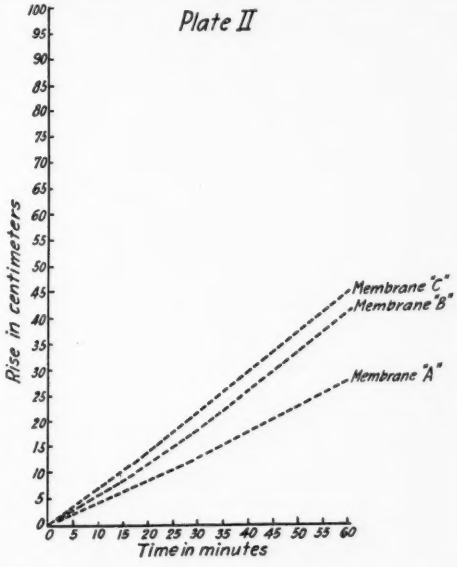
During the purification of a ferric oxide sol by dialysis, a high osmotic pressure was noted which agrees with an earlier observation by Zsigmondy. ("Chemistry of Colloids," Trans. by Spear, **1917,** p. 33.) This fact suggested that such a sol might be used, with suitable apparatus, to demonstrate osmotic pressure. As speed of dialysis and simplicity of apparatus were the prime factors in this case, a membrane was desired which would give the most rapid dialysis per square centimeter of surface. Collodion, parchment, cellophane, and gold-beater's skin were used. According to Zott (*Ann. Physik.*, **27,** 229 (1889)), gold-beater's skin is the best membrane for dialysis and such proved to be the case in this experiment.

The concentration of the sol, which was prepared by the hydrolysis of ferric chloride, was the next factor to be considered. As the osmotic pressure of a ferric oxide sol varies directly with the number of particles per unit volume (Svedberg, Report of Faraday Society and Physical Society of London, Oct., **1920,** p. 5), it was desired to make the sol as concentrated as possible without running into danger of coagulation.

Preparation of Apparatus and Solutions

Thirty cubic centimeters of a stock solution of ferric chloride, made by dissolving 35 gms. of anhydrous salt in 100 cc. of water, were added to 100 cc. of boiling water. This gave by hydrolysis a ferric oxide sol, the disperse phase, according to Pauli (Report of Faraday Society and Physical Society of London, Oct., **1920,** p. 14), being a complex salt with the formula, $x\text{Fe(OH)}_3.y\text{Fe}|\text{An}$, where "An" represents the anion of the salt from which the sol was prepared.

The apparatus was made by cutting the stem from a thistle tube about two centimeters from the bulb. The membrane was then placed over the mouth of the bulb and held in place with a rubber band. A water-tight fit was insured by cementing the skin in place with collodion. The bulb was filled by means of a small funnel which can be made by drawing out a test tube into a fine stem.



A piece of glass tubing about one meter long with an internal diameter of 2 mm. was next attached with a short rubber connection and the bulb immersed in distilled water. The liquid rose in the tube due to hydrostatic pressure, and the zero reading was taken at this point.

Experimental Work

As would naturally be expected, different samples of gold-beater's skin gave slightly different results. In order to show how they might vary, three samples were used and curves plotted, showing the rise per minute. A reading was taken every five minutes. The curves on Plate I show the result using the sol mentioned above. The curves on Plate II show the result obtained with a sol, one-third as concentrated. All experiments were carried on at room temperature, the osmotic pressure of a ferric oxide sol having been found to diminish with rise in temperature. (Zsigmondy, "Chemistry of Colloids," Trans. by Spear, **1917,** p. 44.)

THE MICRO BURNER FOR USE IN ELEMENTARY GLASS-WORKING

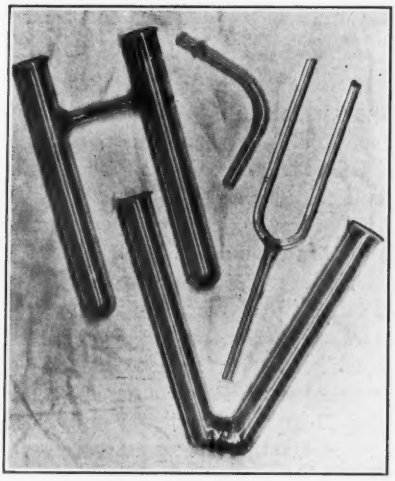
RAYMOND B. WAILES, WASHINGTON, D. C.

The usual method employed by a student in bending a length of glass tubing is to place it in the Bunsen flame and when it has become hot, to exert pressure as one would in breaking a twig. The resulting flat bend is too well known to need description. Simple glass welding, sealing, or blowing is never attempted.

But such a state of affairs should not exist. A perfect L bend can be made with the flame spreader attachment made to fit the Bunsen burner. Even this attachment can be dispensed with if the tube to be bent is held almost vertically in the Bunsen flame so that a portion an inch or two long is heated.

A simple and inexpensive little burner not frequently seen about the chemical laboratory is the micro burner. This burner produces a fairly sharp pointed flame about three-sixteenths of an inch in width and about two inches long. The possible utility of this burner for glass-working operations such as sealing, fusing, etc., occurred to the writer and the construction of several pieces of simple glass apparatus was attempted. The results of the first attempts can be seen from the photograph. It might be said here that the writer has had no training in glass working, other than that acquired by practice and patience.

The burner is conveniently mounted to a wooden pyramid by means of two screws. No air pressure is required to operate it, so that the only connection to the burner is that of a gas line. The pyramid base makes it possible to direct the flame away from the operator, and the small size of the burner and its base permits considerable freedom in manipulating the work.



The cost of the burner is so small that the item could be furnished to every student as standard locker equipment.

The articles shown in the photo are an H tube and a V tube, both made from six inch by three-quarter inch test tubes; an L bend with a bulbed portion near one end to stretch tubing slipped on at this end and make a more gas-tight joint; a U tube of capillary tubing.

Oxygen-Carrier of Blood Analyzed in Germany. An important step toward the understanding of how the process of breathing sustains life has been made by Prof. Otto Warburg who, in an address before the Kaiser Wilhelm Association for the Advancement of Science at Berlin, demonstrated the constitution and action of the component in the blood which controls the conveyance of the oxygen of the air from the lungs to the muscles. So minute an amount of this compound is present in the blood that it cannot be isolated, yet it is an essential factor in the supply of vital energy to all animals. Its chief constituent is hemin, a chemical compound which has been known for the last seventy-five years, but which was first made artificially in the laboratory a few months ago by Prof. Hans Fischer. It contains iron and is a component of the familiar red coloring matter of the blood, hemoglobin.

But the oxygen-carrier is ten thousand times more sensitive to light than hemoglobin. The color of the light makes more difference than its intensity. Rays of a certain frequency will be absorbed while light of another wave-length will not affect it. One of the derivative compounds can act as a sensitizer to sunshine so that a person taking a dose of it would be light-struck, perhaps fatally, by ordinary daylight, while he would be all right so long as he remained in a dark room.

When the "breath-ferment" described by Warburg is poisoned by combination with carbon monoxide, the combination is readily broken up by faint light, and the ferment can then resume its function of carrying oxygen.—*Science Service*

Correspondence

A CORRECTION

I have just received the February number of your very interesting JOURNAL (of which I am a subscriber from the very first number) and as usual laid aside all my work in order to peruse it. Reading the article of J. R. Sampey on J. Lawrence Smith, I came upon a "howler," which made me immediately take up my pen and write to you this letter, as perhaps you will thus receive it in time to make the necessary correction in the March number.

One page 125 is given a figure purporting to be the "Medal awarded to Dr. Smith by the Turkish Government at the completion of his four years of service in the Empire." Now the medal represented was struck in 1873 on the occasion of the centennial celebration of the Mining Institute of St. Petersburg. On the obverse of it are represented Catherine II and Alexander II and the dates 1773—October 21—1873 are given. On the reverse is represented a view of the Mining Institute (just as it is at present, facing the river Neva) and the inscription says: "In memory of the Centennium of the Mining Institute." I happen to possess a bronze copy of this medal and inclose a rubbing of the reverse containing the said inscription. Any one knowing Russian will translate it for you.

Sincerely yours,
PROF. DR. B. N. MENSCHUTKIN

Leningrad 21, Polytechnical Institute, Flat 76A.

Professor Sampey writes:

I was indeed interested in the letter from Dr. Menschutkin. The Smith medals reproduced in my article are part of an extensive collection of articles of Dr. Smith placed in the museum of the Southern Baptist Theological Seminary at Louisville. Since the collection, as well as the building which houses the museum, was presented to the Seminary by Mrs. J. Lawrence Smith, I never questioned the correctness of cards placed with each medal. If I had had any doubts, it would have been an easy matter to have the inscription upon the medal translated, for there was a Russian student in the Seminary last semester. I regret this error, and I hope you will have it corrected in an early edition of the JOURNAL.

Yours sincerely,
JOHN R. SAMPEY

Howard College,
Birmingham, Alabama

Chemical Digest

ABSTRACTS

Field News and Editorial Comment. EDITORIAL. *Teachers J. and Abstr.*, **2**, 696–9 (Dec., 1927).—Several items of interest are discussed. Attention is called to the need of defining the purposes and curricula of the Junior College. Harvard University has recently lengthened the requirements for the Master's degree (Ed.M.) to two years. It is pointed out in a discussion of the new curriculum in mathematics that in the newer courses there has been a more intelligent selection of subject-matter which is more psychologically organized. A tendency towards converting normal schools into teachers' colleges, resulting in more acceptably trained teachers, is noted.

S. R. P.

Experimental Schools in Soviet Russia. D. L. ZYVE. *Educ. Admin. and Superv.*, **14**, 27–40 (Jan., 1928).—Although handicapped by economic conditions of the recent past and present, by lack of equipment, shortage of professionally trained teachers, and certain restrictions placed on educational initiative, the achievements of the Russian schools are of great significance to all educators. Many experimental schools (called stations) have been organized under the direction of the Commissariat of Education. These activity schools are carrying on extensive research work. The program of the stations is not limited merely to school problems but includes a more or less direct supervision of all activities—cultural, vocational, social, and political, arising in the rural community (85% of the population is rural) surrounding the station. In 1926 research and experimentation were conducted in 41 schools on the reorganization of curricula and courses of study; in 32 schools, on methods of teaching; in 23 schools, on the Dalton Plan; and in many schools on problems of pre-school education, statistical surveys, vocational education, and so on. The educational system seems much more promising than under the old regime.

S. R. P.

Education and Poor Relief. EDITORIAL. *Educ. Outlook* (British), **80**, 5 (Jan., 1928).—The editorial comments on the fact that the State grants and local subsidies for education are still looked upon as devices for helping "the children of the labouring poor." A wholly different policy of State aid is advocated. Too many parents are contributing towards a State educational system which they are not using. According to the official figures issued by the Board of Education, the cost of educating a child in the public elementary schools amounts, on the average, to twelve pounds (approximately sixty dollars). In the secondary schools maintained by local authorities the average cost per pupil is about twenty-seven pounds, but this includes seven pounds, the average fee paid by each pupil. Thus the State spends about twelve pounds (sixty dollars) a year in the early training of every citizen who attends public elementary schools and about twenty pounds (one hundred dollars) in the further training of each of those who attend State secondary schools. (In the United States the average cost per child including elementary and secondary school, is $76.25 according to the September, 1927, issue of the *Research Bulletin of the N. E. A.*)

S. R. P.

The Teaching of Science in Normal Schools and Teachers Colleges. ALICE M. VANDEVOORT. *Teachers College (Columbia) Contr. to Educ. No. 287.*—This study attempted to trace certain significant tendencies in the teaching of science in normal schools and teachers' colleges; to analyze the science curricula offered in these institutions; to determine as far as possible the adequacy of the training of the science teacher for the work placed upon him; and to submit constructive suggestions to aid in modifying the curricula offerings for the training of teachers of science. During the early history of the normal schools, courses in science were organized as informational courses. This period was succeeded by one in which methods courses more or less entirely replaced subject-matter courses. Since about 1910 courses rich in subject-matter have displaced the purely methods courses. Suggestions are made relative to technical, professional, and practice-teaching courses for teachers of science.

S. R. P.

Health Material in Science Textbooks. LOIS MEIER. *Teachers College Publica-*

tion.—In the well-known definition of objectives of secondary education given in the Cardinal Principles of Secondary Education (United States Bureau of Education *Bulletin* No. **35,** 1918) first place was given to the Health Objective. The significance which advocates of science teaching have attached to health has made it important to determine the extent to which it has been recognized in instructional materials prepared for use in science classes in secondary schools. Four textbooks in each of the fields—general science, biology, physics, and chemistry were analyzed. Laboratory manuals were included in a separate analysis. Biology texts devoted about 50% of their space to health, general science 33%, chemistry 11.2%, and physics 2.4%. "Foods" lead all topics in the relative amount of space devoted to health. Carefully prepared tables and charts show in quantitative terms the extent to which health topics receive treatment in the textbooks and manuals analyzed. S. R. P.

Cincinnati Sets the Pace. EDITORIAL. *J. Nat. Educ. Assoc.*, **16,** 229–30 (Nov., 1927).—The question is asked "What is a fair salary?" The answer is the present salary schedule in Cincinnati. A discussion is also given of the advantages that come to the children when scientific management is applied to school problems. A. E. C.

Progressive Education. M. SNYDER. *J. Nat. Educ. Assoc.*, **16,** 235–6 (Nov., 1927).—The characteristics of the newer schools may be considered under twelve headings: schools are for the children; health; freedom; interest; group activity; the individual; friendly relationship between teacher and pupil; creativeness; field trips; esthetics; subordinate importance of the mechanics of teaching; part taken by parents. A. E. C.

Growth through Professional Activities. M. R. BARNETTE. *J. Nat. Educ. Assoc.*, **16,** 247–50 (Nov., 1927).—The necessity for putting teaching upon a professional footing is discussed. A. E. C.

The Metallic State. W. HUME-ROTHERY. *Phil. Mag.*, **4** (Suppl.) 1017–45 (Nov., 1927).—A discussion is given of the applications of theories of the metallic state to properties of metals in the solid forms, other than thermal and electrical properties. The theories applied are: (1) The Free Electron or Electron Gas Theory, (2) The Di-Pole Theory of Thomson, (3) the Theory of Wien and Gruneisen, (4) The Electron Lattice Theory of Lindemann, (5) The Theory of Bridgman. The properties discussed are: compressibility, formation of the crystal lattice, and plastic deformation. The author points out how the electron lattice theory is in agreement with the above properties and in what ways the other theories are lacking. A. E. C.

The Future of Education. W. K. FROULA. *Wash. Educ. J.*, **7,** 35 (Oct., 1927).—A comparison is made between the weather man, the business man, and the teacher. The first two base speculations upon facts, why shouldn't the teacher? A. E. C.

The Ethics of Teaching Service. COMMITTEE W. E. A. *Wash. Educ. J.*, **7,** 41–3 (Oct., 1927).—This is a copy of the code of ethics formulated and adopted by the Olympic Unit of W. E. A. A. E. C.

Teaching Children Self Reliance. MRS. J. H. ROBINSON. *Wash. Educ. J.*, **7,** 43 (Oct., 1927).—Children should be taught self reliance from the time they are babies. Later there should be coöperation on this important factor between the teacher and the parent. Let the child learn by experience and not be continually guided. Let him have responsibilities. A. E. C.

British Scientists Discuss Educational Problems. H. S. BRODE. *Wash. Educ. J.*, **7,** 48–9 (Oct., 1927).—A resumé is given of some of the addresses delivered at the meeting of the British Association for the Advancement of Science, A. E. C.

Education and Public Morals. V. K. FROULA. *Wash. Educ. J.*, **7,** 69–70 (Nov., 1927).—A very interesting article in defense of youth. A. E. C.

Sidelights and Impressions of the World Federation of Education Associations. M. B. STRECKER. *Wash. Educ. J.*, **7,** 70–2 (Nov., 1927).—An informal report filled with the good-will and desire for world peace that characterized the meeting as a whole. A. E. C.

The Profession of Teaching. W. E. LEONARD. *Wash. Educ. J.*, **7,** 75 (Nov., 1927).—Teaching is a profession. The three definite ear-marks of a profession are (1) the possession of a body of well-established knowledge, (2) the existence of a body of people to apply this knowledge, (3) the imposition of standards of ethical and moral conduct upon its members. A. E. C.

A Catechism on the New Educational Bill. J. E. MORGAN. *Wash. Educ. J.*, **7,** 78–9 (Nov., 1927). A. E. C.

Teachers' Salaries. F. FISH. *J. Nat. Educ. Assoc.*, **16,** 289–90 (Dec., 1927).—A comparison is given of teachers' salaries in different states and of teachers' salaries with salaries of other gainfully occupied persons. A. E. C.

The Sources of Ethical Character. EDITORIAL. *J. Nat. Educ. Assoc.*, **16,** 267–8 (Dec., 1927).—The four great sources of character in the child are discussed, namely, health, experience, intelligence, and ideals. A. E. C.

The Retirement Fund Policy of the W. E. A. S. E. FLEMING. *Wash. Educ. J.*, **7,** 99–100 (Dec., 1927).—Essential information is given on modern retirement provision. This is the first of a series of articles. A. E. C.

Education and Public Morals. V. K. FROULA. *Wash. Educ. J.*, **7,** 101–3, 117 (Dec., 1927).—This article is the second article by Mr. Froula in defense of youth. In this he discusses the adaptability of the school to modern needs. By means of the laboratory method, the schools should be made life-like, so that the pupil may become fitted to take up his responsibilities upon leaving school. A. E. C.

Student Government in High School. A. B. NESS. *Wash. Educ. J.*, **7,** 104–5 (Dec., 1927).—In the West Valley High School the students are under the jurisdiction of the Student Council. The Council is made up of one representative from the freshman class, two from the sophomore, three from the junior, and four from the senior. A monitor system is used in the assembly room. The result has been that the students have more of the fundamental habits of social coöperation instilled in them than formerly under faculty jurisdiction. A. E. C.

America's Influence on the Development of the Sciences. JOSEPH MAYER. *Sci. Mo.*, **26,** 60–9 (Jan., 1928).—M. points out that America stands today in the very forefront, along with England, France, and Germany, in her influence on the development of science. In the early history of American science, the achievements of such men as Benjamin Franklin and Count Rumford are described. Franklin's theory of electricity and his experiments with lightning brought universal recognition while Rumford's proof that caloric is a gratuitous assumption and that heat is a mode of motion led the way to the discrediting of other imponderables. The outstanding accomplishment of Europe in the 18th century was the establishment of chemistry at the hands of such men as Lavoisier. The 18th century saw an unprecedented development in all scientific departments. M. likens the scientific structure to a building of several stories of which mathematics constitutes the foundation, physics the first floor, chemistry the second, and modern astronomy, geology, biology, and psychology the third, fourth, fifth, and sixth, respectively. Among the outstanding Americans who have helped to develop this structure, Willard Gibbs is mentioned for his work in mechanics and chemical equilibrium, and Joseph Henry for his work in electricity, Other names appearing in connection with the physical sciences are Rowland, Richards, Michelson, Morley, and Millikan. Agassiz, Silliman, and others did much for the development of geology while Morgan, Wilson, Jennings, Wheeler, Osborn, and Loeb stand out prominently in the biological sciences. In psychology, William James stands foremost. G. W. S.

The Race for Sweetness. J. J. WILLAMAN. *Sci. Mo.*, **26,** 76–86 (Jan., 1928).—A discussion of the various sugars is given, including their sources, relative sweetness, and commercial values. The nature and possible value of some recently discovered sugars are discussed. G. W. S.

Blue Laws for School Teachers. STEPHEN EWING. *Harper's*, **156,** 329 (Feb., 1928).—In any number of communities the public school teacher no more dares to call her soul her own out of the school room than she does in it. If her social behavior is at all out of the ordinary she lays herself open to censure or even dismissal when her year's contract expires.

Actual rules, or sentiment equivalent to rules, exist against bobbed hair, short skirts, gay colors, smoking, "dates," dancing on school nights, and walking home with the principal. Very few states have a tenure of office law which protects the teacher against discharge for any of these.

Positive demands are made, in many places, that teachers engage in church work and that they spend summers at normal schools (regardless of previous training), when they should have their time for recreation.

The rules against married women being employed are regarded as especially unjust as the jobs should be given on the basis of capability. A recent survey of principals showed 597 found no difference between married and unmarried women, 174 were against married women, and 42 said they were the best. Courts in several states have held marriage cannot be used as a legal cause for dismissal.

As a result of these "blue laws" our children, going to school to men and women who have had to stifle their own convictions, will not learn the courage that is born of independent thought. The teacher of various experience and broad knowledge of the world and its ways will quicken the imagination of the young and stir them to dream great dreams. J. W. H.

What Is Wrong with Education? ORREN C. LESTER. *Am. Educ. Digest*, **47**, 205 (Jan., 1928).—The failure of education to give young people a sense of the problems that they will be called upon to manage when they enter their after-school life is the crux of the whole weakness of the public schools.

To remedy this there should be courses in: (1) The elementary laws and habits of health; (2) economic guidance with emphasis on selection of life work, elements of success at a life job and the management of an income; (3) interpretation of democratic citizenship that will raise the standard of community life; (4) modern social arts; (5) ethics with emphasis on individual integrity, honesty in business, respect for the rights of others, and a knowledge of moral values.

The subjects now primary should not be scrapped, but reduced to secondary position and made supplementary to a more vital and practical educational formula.

J. W. H.

Teaching as a Profession. DR. FRED HUNTER. *Am. Educ. Digest*, **47**, 219 (Jan., 1928).—A profession is a distinctive type of service that contributes necessary and vitally significant things to the community to which it administers. It must add to the economic prosperity of the people whom it serves; preserve and create ideals of individual and national life; contribute to the personal and group cultural life; have a specified, standardized, scientific procedure; have a sound economic basis and a solidarity in the worthiness of the work undertaken.

The question, *Can Teaching Become a Profession?* becomes a problem ultimately of the teacher. Teachers must say whether it is a job that draws a warrant at the end of the month or an eternal contribution to the ages, the labor of a profession.

J. W. H.

The Abdication of Reason. ROSCOE POUND. *Bull. of Am. Assoc. Univ. Profs.*, **13**, 569–74 (1927).—The author emphasizes the need for the application of rational principles in adjusting a more or less static political system, involving laws and judiciary systems, to a changing social order. He emphasizes for the social, the political, and the economic world a "true balance between the need for stability and the need for changes." He pleads for professors in such fields, who become "unorthodox," in language strangely similar to that used by apologists for evolution-believing scientists. B. C. H.

Some Round Table Questions. AMELIA WEBERS. *Neb. Educ. Jour.*, **7**, 619 (1927).—The report of questions submitted at a Science Teachers' Conference. Those of interest to teachers of chemistry: "Is a fundamental study of chemistry necessary in a high school of but one hundred students? When introduce valence in first-year chemistry? What value should be accorded to laboratory work in figuring up the final grade? Are new type 'objective' tests suited to chemistry? How many problems in chemistry? Should ability to solve problems be required of students seeking credit in high-school chemistry?" B. C. H.

A Brief Resumé of the Chemical Warfare Service Boll Weevil Investigation. H. W. WALKER. *Chem. Warfare*, **13**, 231–7 (Dec., 1927).—A brief discussion of the boll-weevil problem is given in connection with a short life history of the weevil.

During this investigation over 100 poisons were tested, requiring the use of over 250,000 boll weevils. A summary of the results obtained with a few of the more successful poisons indicates that calcium arsenate and sodium fluosilicate are of nearly equal value in combating the weevil and are far ahead of other poisons. A special calcium arsenate containing only 30% As_2O_5 was found to be as effective as the commercial poison containing 40% As_2O_5 and, of course, much cheaper. The sodium fluosilicate is a by-product of the manufacture of acid phosphate fertilizer. E. R. W.

Science and Industry. GEORGE GREY. *Chem. & Ind.*, **46**, 1117–22 (Dec. 2, 1927).—The chemist to be of greatest value in industry must have, besides his knowledge of chemistry, the ability to recognize industrial problems, a knowledge of the powers of investigation and deductive reasoning in solving these problems, and a sense of his responsibility in attempting their solution. He should be able to organize his work and the work of those under him, and have the personality to enforce his organization plans. E. R. W.

Are the Colleges Turning Away as Many Students as Reported? EDITORIAL. *School*, **39**, 352 (Dec., 1927).—The article on "Over Population of the Colleges" by President James Rowland Angell of Yale has been spoken of rather scathingly by Dr. Burdette Ross Buckingham in New York recently. Entrance requirements at Yale were tightened, which resulted in a better tone in the University. Suggestions were made that further efforts be used (1) to keep students out of University, (2) to reconstruct our whole educational program from kindergarten up, emphasizing intellectual standards and introducing competitive selection in order that our education be not

"shoddy and superficial, permitting young people of the slenderest and most meager intellectual powers and achievements to go forward to it."

Buckingham believes that the colleges must meet the situation by ministering in some way to those who desire to pursue higher education.

President Daniel Mousle of Boston University believes the number of applicants is exaggerated due to the growing number of students who apply for admission to several institutions simultaneously. E. L. M.

Tri-Grouping at the James Madison High School. A. M. CLARK. *School*, **39**, 349 (Dec., 1927).—An experiment in classifying pupils throughout the entire school course was inaugurated at James Madison High School in September, 1926, reports the principal, A. Mortimer Clark.

Two courses are offered: a commercial and a general course. Electives in both may be chosen from major art, shop work, home economics, and art weaving. The registration of the school is six thousand. The entering class averages nine hundred. The entrants are given the Otis test and classified according to the I. Q. obtained. The higher group (I. Q. above 110) is designated as the King Oaks School, the middle group (I. Q. 90–110) is designated as the Midwood School, and the low group (I. Q. below 90) is designated as the Vandeveer School. Exact status of the student is not concealed. The curriculum of the King Oaks School is greatly enriched—it is distinctly a college preparatory in the general course. The ordinary high-school curriculum is given in the Midwood school, which is the largest. It is a homogeneous group. The Vandeveer School is a most heterogeneous host of people—in this there are all kinds of abnormal and subnormal students and the course is greatly modified.

With such a grouping the following tendencies have already been noted:

1. There has been a sharp upward rise in scholarship.
2. There has been a marked improvement in attendance.
3. The disciplinary difficulties anticipated in the Vandeveer School have not yet materialized. There has been a decline in the number of disciplinary cases.
4. Many Vandeveer students have radically changed their attitude towards school work. About 140 were promoted into Midwood on Feb. 1st last (1927).
5. School mortality has declined.

E. L. M.

Samuel Wilson Parr—the Society's President for 1928. W. A. NOYES. *Chem. Bull.*, **15**, 3 (Jan., 1928).—Professor Parr is the new president of the American Chemical Society. Nationally and internationally he is known as a scientist and as an authority on the chemical composition and classification of coals. His sodium peroxide calorimeter first made it practically possible to determine the value of commercial coals. He, with the assistance of Dr. Layug, his associate in the Division of Applied Chemistry at the University of Illinois, discovered an exothermic reaction in the coking of coals by which a hard coke is now made commercially from Illinois coal in four to five hours instead of the seventy-two hours formerly required. Parr is also noted for the discovery of an acid resistant alloy, Illium. It is used to take the place of the calorimeter with a platinum lug. He has served as Director of State Water Survey and contributed in many other ways to industrial chemistry.

His work as a teacher is probably his best-known and finest contribution, and is so intimately bound up with his research achievements that they are inseparable. He has inspired hundreds of students by his personal character and work and his kindly advice to those entering upon a chemical career. His recommendations of students were of unique value due to his good judgment of their qualifications. Employers put great confidence in his ability to place the right man in the right place.

He was born at Granville, Illinois, in 1857. He graduated from the University of Illinois in 1889 and studied later at Cornell, Berlin, and Zurich.

Professor Parr is not merely a scientific man of extraordinary accomplishments; but has contributed largely to the civic and religious life of his community.

E. L. M.

Inhibitors: Their Behavior in Laboratory and Plant. F. N. SPELLER AND E. L. CHAPPELL. *Trans. Am. Inst. Chem. Eng.*, **19**, 153–63 (1927).—The rate of attack of metals by acids may be greatly decreased by the addition of substances called inhibitors. Some substances used for this purpose are: arsenic, barium, and lead compounds, cyanides, glue, flour, formaldehyde, carbazole, aniline, alcohol, pyridine, acid extract of coal tar, quinoline, quinoline ethiodide, a product obtained by sulfonating slaughter house waste, and a sludge from coal-tar treatment.

The effectiveness of an inhibitor may be shown by the reduction in the number of cubic centimeters of hydrogen evolved from an acid in contact with a metal after the addition of the inhibitor. 0.6 cc. of hydrogen per sq. cm. of steel in contact with 34%

H_2SO_4 was collected in about $1^1/_3$ hours as compared with about 0.02 cc. during a period of 18 hours after adding 0.1% of quinoline ethiodide. The use of inhibitors will result in a decrease of acids used in pickling baths, the preservation of the metal surface, avoidance of the embrittlement of wires due to hydrogen, and reduction of acid fumes and vapors carried into the air by the hydrogen spoilage of product due to careless workers. G. B. H.

Rubber in Engineering. J. W. SCHADE. *Trans. Am. Inst. Chem. Eng.*, **19**, 57–70 (1927).—Because of its resistance to abrasion, soft rubber is used in the manufacture of tires, soles, heels, rubber-covered belts, etc. Belts 48 inches wide and 610 ft. long have been used 5 years to convey 16,363,000 tons of ore with practically no attention or repair. One user observed that the pulley, over which ran a belt with a $^1/_{16}$-in. rubber covering was worn away before the rubber covering on the belt was gone. Rubber-covered chute plates, against which sand and gravel were thrown, have been found to do the work of ten steel plates.

The high frictional resistance of rubber is made use of in making belts for transmitting power, but this frictional resistance may be so reduced by proper compounding as to permit the use of rubber bearings for steering wheels of automobiles. The low frictional resistance of rubber wet with water is utilized in designing bearings for boats, water turbines, and deep well pumps. A pleasure yacht used one set of rubber bearings for 18,000 miles travel as compared with 5 babbit and bronze bearings for the previous 18,000 miles of travel.

The property of resisting shock and eliminating noise is utilized in making rubber mallets, cushions for steam hammers, shackles for heavy trucks, shock absorber cords for airplanes, table tops, etc.

The flexibility of rubber makes it well adapted for tires, hose, belting, paper mill and printing rolls, universal joints, gaskets and packing against steam, water, or gases, etc.

Rubber is not only impervious to water but has a low heat conductivity so that rubber-lined pipes have been used in conveying hot water efficiently. By properly compounding, rubber has been used to line apparatus, pipes, and valves, to give protection against acids and alkalies. Petroleum and its products may be readily conveyed through properly prepared rubber hose without causing deterioration. G. B. H.

Removal of Rust from Pipe Systems by an Acid Solvent. F. N. SPELLER, E. L. CHAPPELL, AND R. P. RUSSEL. *Trans. Amer. Inst. Chem. Eng.*, **19**, 65–171 (1927).—A new method of removing rust and other substances from pipe systems in which the capacity of the system had been seriously diminished has been developed. The removal is accomplished by draining the system and filling with a hot solution of commercial hydrochloric acid which has been diluted somewhat with water and to which is added an inhibitor. The acid mixture is allowed to remain in the pipes 6 hours and then the system is thoroughly drained and flushed. An inhibitor must be present to reduce the attack of the acid on the metal pipes. The cold water piping in a 35-story office building in New York City was given this treatment and the lines were out of service from 2 P.M. to 10 P.M. The only alternative was to replace the entire system of piping at a cost which was estimated as between $100,000 to $200,000. It is believed that a modification of the system will permit the removal of carbonate scale. G. B. H.

Alchemy—Past, Present, and Future. ODEN E. SHEPPARD. *The Hexagon of Alpha Chi Sigma*, **18**, 235–44 (Feb., 1928).—The announcement of Miethe and Nagaoka on the preparation of gold from mercury and Paneth on the transformation of hydrogen into helium prove that "the fundamental idea of alchemy is still alive." Paneth says, "It was never entirely abandoned although, after chemistry had won a much higher position, the disfavor of the scientists forced it for a time to hide in the obscurity of private laboratories and secret societies." In its broader sense alchemy was the art of curing metals and animals of their ills, the belief being that if the metal were brought to a state of perfection the result would be gold.

The origin of alchemy is ascribed to various sources, the Egyptian god Hermes-Troth, the revelations made by fallen angels, while it is also claimed that God revealed it to Aaron and Moses. The origin of the word is also obscure. It might come from the Arabic *Al Chema*, The Hidden Science, or the Greek word indicating pouring.

The idea of alchemy probably originated with the Alexandrian Greeks soon after the beginning of the Christian era. Many supposedly earlier writings were written by later alchemists who ascribed them to prominent men of antiquity to lend them authority. Gibbon says the destruction of the Alexandrian Library in 290 A.D. is the first authentic event in the history of alchemy. The decree stated that all books giving methods of making alloys simulating gold or silver should be destroyed, as few people could distinguish between the true and false. On the four element basis, earth,

air, fire, water, one element water is transformed into another, air or steam, why then may not fire transform one metal into another?

The theory of alchemy was that everything was composed of a prime substance which was found to be a special form of mercury. Things differed due to the qualities imposed on this prime substance. The alchemists desired to remove these qualities and add desired ones by the treatment with sulfur and arsenic. Bacon said, "All metals are begotten of silver and sulfur. Nature always intendeth and striveth toward the perfection of gold, but many accidents coming between changeth the metals. For according to the purity of the quicksilver and sulfur, pure and impure metals are engendered."

Many alchemists were corrupt and, realizing the futility of their search, used their wits to dupe the more credulous. These are described by Ben Jonson in The Alchymist. Others believed by diligent study they could discover the Philosopher's Stone. "To these poor, honest, misguided wretches chemistry owes its beginnings."

Van Helmont, 1640, was the last person of note who claimed to have made gold. Alchemy lived long and exerted a profound influence, yet it is difficult to point to a truly authentic transmutation. "What we wish we believe, what we expect we find." The deposition of copper on iron pots when placed in certain streams was accepted as an evidence of transmutation. The writings of the alchemists were in mystical language, which was probably no more mystical than the modern alchemy where the removal of an alpha particle may result in a new element.

The modern alchemist suggests that all elements may be built from one or two fundamental units, H and He, or perhaps the electron and proton. He may go further and doubt whether there is a difference between energy and matter. They are simply two measures of the same thing, differing from each other by the square of the velocity of light. In the reaction $4H = He$, the loss in weight is 0.032 gram, which appears as a million calories of heat, which may account for the very slow cooling of the sun. "The dream of the modern alchemist might well be, not to produce gold but to destroy it and from each gram obtain 9×10^{20} ergs of energy worth a quarter of a million dollars at ten cents per kilowatt hour."

In a different way, modern alchemy has been utilized in explosives, medicines, dyes, etc., and in the formation of alpha antialdoxime or peril-aldehyde which has 2000 times the sweetening power of sugar and 4 or 5 times that of saccharin. The modern alchemist "believes that he can tell the number of molecules in a cubic centimeter of water more accurately than we know the population of New York City." Aston has presented some of these statistics in a striking way. Take a tumbler of water, label each molecule, and throw it into the sea and wait until completely mixed with all the other water in the world. Fill a tumbler with water and it will contain 2000 of the original molecules. At 25 cents a trillion, one German mark would buy 1,150,000,000 atoms of gold.

For the alchemy of the future he recommends the address of Cady on "The Chemistry of the Future" in *Science*, Jan. 7, **1927.** "By 1977 corrosion problems will probably have been solved by the simple means of converting the corrodible elements into the non-corrodible ones as for example using platinum for the steel frames of sky scrapers." In conclusion he commends the advice of Dr. Fotte, "May I counsel those who are discouraged and disappointed in the present status of alchemy to take comfort in one of the Proverbs of Solomon, 'How much better it is to get wisdom than gold.'"

D. C. L.

The Demonstration Method versus the Laboratory Method of Teaching High-School Chemistry. W. W. KNOX. *Sch. Rev.* (Univ. of Chi.), **35,** 376–86 (May, 1927).—A test conducted on two groups of 42 and 43 students, respectively, under conditions made as nearly similar as possible to determine which method of teaching scored highest in (1) immediate retention, (2) delayed retention, (3) method of attack. The demonstration method rated highest in each. Further study indicated that the laboratory method was better for inferior half of group for immediate retention, but demonstration method was better for superior half. For delayed retention the laboratory method was best for the inferior half of group. There was a slight advantage in demonstration method for method of attack. Sigma scores and other findings are included in article. B. H. B.

Science Department Meeting. ALEX. BRODELL. *Sch. Rev.* (Univ. of Chi.), **35,** 428–47 (June, 1927).—A complete yearly agenda with subject-matter, references, etc., for a year's departmental work, meeting monthly. B. H. B.

The "A" Tube—An Improved Form of "U" Tube. A. O. JONES AND F. HOBSON. *Chem. & Ind.*, **46,** 1222–3 (Dec. 30, 1927).—The A tube which the authors describe

and illustrate might be made by connecting two straight tubes a short distance from the bottom of each in such a way as to form an H. Inlet and outlet arms are then formed by drawing out and bending away from each other the tops of the two vertical tubes. These tops are then brought together by a slight bend where the connecting tube is attached to the vertical tubes. The bottoms of the upright arms may be closed with stoppers. Such a tube is more stable than the ordinary U tube, and is also more easily made, cleaned, and filled. The dead space in each upright tube below the cross tube may offer a slight disadvantage in some work. E. R. W.

Objective Measurement of Teacher Traits. B. K. BAKER. *Sch. Board J.*, **75**, 43–5 (Dec., 1927).—The author advocates the use of objective terms in describing the product of the teachers' college, stating that only when such terms are used, will school officials speak a common language. The term "good teacher" may mean any one of a number of different things to various people: an ability to conduct a class efficiently; to coöperate with one's colleagues and superiors; to maintain discipline; or, perhaps, tact and social grace. At present no standard units of rating exist by which such traits can be measured. K. S. H.

An Interpretation of Teacher Training. EDITORIAL. *Univ. of Pittsburgh Sch. of Educ. J.*, **3**, 30–1 (1927).—The editor questions the wisdom of considering a high-school teacher's courses in education as his "professional training," and all other training as "academic." ".....It (the above classification) imposes limitations upon the scope of the teacher training function which are illogical and unfortunate." The large variation in quality and type of education under the curricula followed by prospective high-school teachers, often leaves grave deficiencies in knowledge of the subject-matter to be taught. The prospective instructor may know "how," but often does not know "what" to teach. Secondly, "the courses in education pursued by the prospective high-school teacher ordinarily do not total more than 15 or 20 semester hours. The conception of the high-school teacher's preparation as liberal education plus a few courses in pedagogy has long been a stumbling block in the way of educational progress." "The method of functional analysis, which must be employed in teacher training shows us the true scope of 'professional' education in this field." V. R. THAYER

Learned Men and Scientists. DIXON MERRITT. *Outlook*, **148**, 51 (Jan. 11, 1928).—A whimsical discussion of the distinction between learned men and scientists. G. H. W.

An Experimental Test of Intellectual Honesty. G. F. MILLER. *Sch. and Soc.*, **26**, 852–4 (Dec. 31, 1927).—Two groups of students were selected as subjects for this test and were subjected to the same instruction, directions, examinations, etc., the situations for both groups being made as uniform as possible.

The data of this experiment, which was secured through three objective tests given at intervals of about eight class periods, is tabulated for each group, the methods of obtaining it explained, and its significance interpreted. K. S. H.

"Education" and the College Professor. G. WAKEHAM. *Sch. and Soc.*, **26**, 812–4 (Dec. 24, 1927).—A recent survey shows that teaching ability is little considered in the selection of candidates for teaching purposes. Spectacular research and the right to claim authorship to some sensational articles and novels now and then are considered by many college presidents as good advertising for the university.

For many reasons "education" and education courses mean little or nothing to the average college teacher aside from the amount of time which he considers such courses unfairly monopolize. The fact that many of the rules and principles which educational systems are forced to recognize are formulated by "educators" whose popularity and efficiency are based on a series of honorary degrees, and their ability to advertise further lowers in his estimation any value which they may have. As a result of these various precepts many individuals go out, particularly into the rural districts, to teach a subject of which they have little or no knowledge.

Education needs some adaptations. The status of the high school of some years back, when those who were graduated were fit and qualified, has changed to an endless, unselected, drifting mass. The curriculum has become generalized with a smattering of this or that but no mastery of any one particular branch. The university and college have been neglected in an attempt to "perfect" the high school. The application of stereotyped principles has been the aim rather than the presentation of fundamentals.

The author urges the occasional recognition of the faithful and efficient teacher by the department head or dean even though he does not shine at publicity. K. S. H.

The Liberal Element in Professional Education Courses. C. D. CHAMPLIN. *Sch. and Soc.*, **26**, 682–5 (Nov. 26, 1927).—The author feels that education courses

should not be regarded as a means of fulfilling state requirements, but that they should have a decided place in the college curriculum and should be given by able teachers. Courses in the History and the Philosophy of Education have cultural value as well as professional. The most successful young teachers appear to be those who, through good education courses, have acquired a philosophy of teaching and self confidence. The establishment of Teachers Colleges and Schools of Education are important steps in educational progress and since there is ample room for both there need be no conflict between these schools and colleges of liberal arts. K. S. H.

Certification Requirements of Teachers of Secondary School Science in Certain Southern and Border States. W. W. CARPENTER. *Sch. Sci. and Math.*, **27,** 929–36 (Dec., 1927).—A study of the requirements in science for certification in various schools of the southern section and border states with data, standards, and tabulations.

Need for such study is evident from results of a similar study by Hutson in which it was found that, of 230 science teachers of Minnesota, 50.9% of those teaching chemistry were prepared to teach the subject. B. H. B.

Laboratory Unknowns in General Chemistry. LYMAN J. WOOD AND SEWARD E. OWEN. *Sch. Sci. and Math.*, **27,** 919–25 (Dec., 1927).—The use of a series of unknowns, some quantitative, others qualitative, intended to replace the purely confirmatory experiments, the results of which are known to the student in advance, is discussed and various typical "unknowns" are listed, with methods of use, schemes for checking results, and limits of experimental error.

It is claimed that the plan suits the difficulty of the laboratory work to the students ability, stimulates interest because of necessity of doing individual work on his own assignment, and requires results known to be acceptable. B. H. B.

Hide and Seek with Radium. R. L. DOAN. *Sch. Sci. and Math.*, **27,** 910–2 (Dec., 1927).—An article on the method of search for lost radium needles or capsules. B. H. B.

The Place and Problems of Chemistry in the High-School Curriculum. M. F. STUBBS. *Sch. Sci. and Math.*, **27,** 741–8 (Oct., 1927).—Changing purposes and aims in high-school chemistry because of preparation of majority of students for life rather than for college entrance; discouraging showing of chemistry in barely holding its percentage of students; and results of studies on mastering subject-matter of high-school chemistry, lead author to two general objections:

1. High-school chemistry is still too much under the influence of the college and the benefits of such dominance are outweighed by the defects.
2. Present-day methods often aim to turn out chemists rather than intelligent citizens who are appreciative of chemistry.

Author believes second objection can be overcome by selection of subject-matter according to general aims stated by Downing.

1. Only matter socially worthwhile.
2. Only topics that follow native interest of boy or girl.
3. Only matter which lends itself to the following general aims: appreciation of commonplace environment, new knowledge applicable to various fields of human endeavor, and training in scientific thinking.

First third of course usually consists of laws and theories, which are not only the hardest but usually the least interesting material. Author advocates presenting these theories in an understandable way and graduated in difficulty, meanwhile holding interest by some such stimulant as the reading of "Creative Chemistry." Next, falling off of interest usually occurs in latter part of second semester in study of descriptive matter not conducive to thought—and can be met by project method. Laborious copying of laboratory notes dampens interest and recent studies seem to show that his drudgery can be well replaced by a few selected questions on the experiment—or in many experiments by lecture demonstrations.

Author also points out disconnected nature of high-school science and need for universally recognized list of minimum essentials. The scheme whereby some colleges allow entering students to take only a half-year course in college chemistry, if they had a course in high school, is commended. B. H. B.

The Math. and Science Curricula in Junior and Senior High Schools. C. V. GOOD. *Sch. Sci. and Math.*, **27,** 863–9 (Nov., 1927).—A report on an investigation to determine objectives, constants, and electives of the secondary school curriculum, with a tabulation as to the frequency of occurrence of aims in mathematics and sciences. B. H. B.

Teaching the Periodic Classification of Elements. R. H. LEROY. *Sch. Sci. and Math.*, **27,** 793–9 (Nov., 1927).—An article descriptive of a type of periodic table for which the following features are claimed:

1. The name OA has been discarded and Transition A adopted as being a better term to describe the inert gases in their new position.
2. The inert gases are used to emphasize the difference of properties of the elements of groups VII A and IA.
3. All the "A" groups are together, as are the "B" groups.
4. Each numbered group of both the "A" and "B" series occupy the same relative positions, thus making for simplicity and uniformity.
5. A difference in the horizontal spacing of the positions of the elements of the "A" and "B" groups is used to emphasize the "horizontal" relations of the "B" group elements as contrasted to the "vertical" relations of the "A" group elements.
6. A place is satisfactorily provided for the rare-earth elements. B. H. B.

Science Books in the High-School Library. B. C. HENDRICKS. *Libr. J.*, **52**, 1073–6 (Nov. 15, 1927).—An investigation made in 1926 by the Committee of Chemical Education of A. C. S. (J. CHEM. EDUC., **4**, 911–3 (1927)) showed that 1863 high schools in 28 states averaged only $40.00 a year for books and journals for chemistry. In Nebraska 32 per cent of the high schools made no provision for such.

Reasons for extensive reading of scientific books in high schools by students are given. Thirty-two desirable scientific books for a high school library are listed. The qualities of a good science book and the methods of getting high-school students to read one are explained. J. L. K.

Teaching of Research in Organic Chemistry. J. REED. *Nature*, **120**, 908–9 (1927).—In Professor Alfred W. Stewart's book "Recent Advances in Organic Chemistry," he laments the sudden increase in the last ten years, following an unproductive period in organic chemical research, of the discovery of multitudes of unimportant organic compounds by students working for their doctor's degrees, which discoveries have flooded the literature of the subject burdensomely. It is suggested that a sympathetic handling of cases, where a bold conception accompanied by competent practical work has had only negative results, would encourage research along lines which would ensure more valuable results than the synthesis of useless compounds. A return to subjects of biochemical order would be valuable, aided by an increased knowledge of catalysts and colloids. Research in this field is by the very extensiveness of the subject far ahead of the teaching of it. T. M. M.

Radioactive Nuclei. SIR ERNEST RUTHERFORD. *Sigma Xi Quar.*, **15**, 82–7 (1927).—The nuclei of heavier elements are believed to be of a very compact structure with a radius of the order of 1×10^{-12} cm. Neutral satellites are pictured circulating about these nuclei. For "preliminary calculations. . . show that the attractive forces due to. . . (either electrical fields or magnetic fields or both) are the right order of magnitude to hold the particles in equilibrium when in circulation around the central nucleus."

The "uncharged α particle" is considered as a type of neutral satellite. A brief description is given of the mechanism of α particle emission. β-Ray particles are claimed to be the electrons stripped from the neutral particles as they escape from the nucleus.

This hypothesis "offers a reasonable explanation of the existence of a number of the isotopes of an element of a given atomic number."

A later paper is promised with a "fuller discussion of this type of nucleus structure." B. C. H.

How Should a Storage Magazine Be Illuminated? ANON. *The Explosives Eng.*, **6**, 30 (1928).—There is a strong probability that a d. c. lamp will explode. Such explosions have been found to detonate caps in the vicinity, particularly if in an open box. A. c. is much safer. When d. c. must be used to illuminate a magazine, it is imperative to install conduits, vapor-proof fittings and fuses (not over 10 × the lamp capacity). R. A. B.

Ice ("When Ships Carried Ice of Nature's Making to Distant Countries"). C. H. VIVIAN. *Comp. Air Mag.*, **33**, 2311–2 (1928).—Less than a century ago, there was no manufactured ice; ice was available only to those living in or near cold regions. The first recorded introduction of ice to the tropics was in 1805 in the form of a shipment of 130 tons from Boston to Martinique. People had to be educated to use ice for cold or frozen drinks, or for the preservation of food. Massachusetts became the refrigerating center of the tropical world. In 1841 there were 15 competitors in the field; by 1850 the ice trade included every large port in South America and the Far East. Every New England pond near tide water was used to furnish this ice. In 1834 the charge was 3 cents per pound in Havana, and 2 cents in New Orleans. At present, ice can be produced at a fuel cost of 25 cents per ton. Per capita use in the U. S. in 1927 was over half a ton. The ice box is one of the most potent agencies in the reduction of infant mortality. R. A. B.

Physical Chemistry—Gaseous Explosions. R. K. SCHOFIELD. *Sci. Progress*, **22**, 400–5 (Jan., 1928).—A summary is given of the experimental and theoretical work, which has been done on gaseous explosions, with special attention to the work of the last few months. In general, gaseous explosions pass through certain well defined stages, with the flame advancing relatively slowly and usually at a constant speed, followed by a vibratory movement, and, under certain conditions, detonations.

Arrhenius' theory is generally accepted, namely, that the activation of one or both reactants is a necessary precedent to their chemical interaction. The exact nature of activation is unknown. References are given.

The Nature of Matter and Its Relation to the Ether of Space. SIR O. LODGE. *Sci. Progress*, **22**, 435–43 (Jan., 1928).—Action cannot take place at a distance. There must be an intervening medium which acts as a transmitter. All activities which involve potential energy are dependent upon ether. Ether connects all matter and is the transmission medium for light, gravitation, cohesion, elasticity.

Atoms consist of a nucleus with planetary electrons. The constitution of an electron is not known, but it is an electric charge. It is a seat of energy in the ether and may be a modified portion of the ether. If this is true then matter is ultimately composed of ether.

L. considers that life and mind are not directly associated with matter, but are indirectly associated by means of the ether; and therefore, the body consists of mind, ether, and matter. Matter is distributed throughout the universe. The two greatest discoveries of the last twenty-five years are, first, the equation or identity between matter and energy and, second, the discovery of the quantum. A. E. C.

Graphical Methods in Teaching and in Research. A. FERGUSON. *Sci. Progress*, **22**, 461–74 (Jan., 1928).—The method given for teaching Boyles' law might be utilized in a chemistry class, but is better suited to physics for an individual laboratory method. A. E. C.

Utilizing Waste. G. TEMPLE. *Sci. Prog.*, **22**, 475–80 (Jan., 1928).—Bagasse or waste crushed sugar cane consists of very long fibers. These fibers have microscopic hooks on the sides and consist mainly of air cells. This waste has been made into the commercial product celotex. Celotex may be used in place of wood or plaster in construction work. It is a better insulator than wood or plaster, due to the dead air spaces within the fibers. Its manufacture consists of cooking the waste in vats (dissolving out of soluble matter), repeated washings, floating the fibers off and smoothing them to an even depth, placing them in a powerful press, and felting them into a continuous board of the required thickness and width. The wet plank passes into a drying machine where it is dried and sterilized at 350°F. Issuing from the dryer, celotex is cut into the required lengths and stacked. A. E. C.

Teacher Rating. B. E. DAVIS. *J. Nat. Educ. Assoc.*, **17**, 4 (Jan., 1928).—In two surveys that have been made, it was found that over seventy per cent of the schools studied used some system of rating their teachers. The reasons for rating were: to promote teacher efficiency; stimulate self improvement; eliminate unfit teachers; determine salary increases; aid in supervision; and to furnish private information to the principal or superintendent. At present there is no rating plan which is infallible. A. E. C.

Clerks for Teachers. P. A. MAXWELL. *J. Nat. Educ. Assoc.*, **17**, 8 (Jan., 1928).—In a Pittsburgh high school the average teacher spends 57 minutes a day doing clerical work, namely, records of attendance, classification, measurement, books and supplies, and the like. If a clerk was substituted for every sixth teacher, the other five teachers could do the work of the sixth teacher and not be diverted from actual teaching by the making of reports, and the clerk could devote her full time to making reports, which would probably be more accurate. In addition the cost of running the school would be cut $1316 a year. A. E. C.

Commencements in Doylestown. COMMITTEE OF SENIORS OF DOYLESTOWN HIGH SCHOOL. *J. Nat. Educ. Assoc.*, **17**, 9–11 (Jan., 1928).—The commencement presents some definite piece of work which is not only instructive, but informative and useful to students, parents, and the community in general. The report is on "Failures in High School." From office records for 1922–1926 it was found that there were ten per cent failures. The subjects which caused the most failures in descending order were: Latin, history, mathematics, commercial subjects, and science. The causes of failures as stated by the teachers were: irregular attendance, inattention and carelessness, lack of home study, poor effort, lack of application, and too many social activities. In comparison, students considered the following as causes for

failure; lack of home study, poor effort, inattention and carelessness, not made to work, no interest in school work. A. E. C.

The New Education in New Russia. L. L. W. WILSON. *J. Nat. Educ. Assoc.*, **17,** 15–7 (Jan., 1928).—An interesting summary is given of the present educational methods in Russia. A. E. C.

Principles of Tenure. EDITORIAL. *J. Nat. Educ. Assoc.*, **17,** 18 (Jan., 1928). A. E. C.

The Journal's Annual Roll Call. EDITOR. *J. Nat. Educ. Assoc.*, **17,** 19–25 (Jan., 1928).—A digest is made of the reports on educational progress in the States. A. E. C.

The New Education Bill Itself. EDITOR. *J. Nat. Educ. Assoc.*, **17,** 33–4 (Jan., 1928).—The Education Bill is given in full, with a short article pointing out the essential points. A. E. C.

The Restoration of Science. F. S. MARVIN. *The Monist*, **38,** 1–17 (Jan., 1928).—This article contrasts the important place of science in the earliest Greek civilization, the establishment of unscientific thinking in the following thousand years, and today's trend to revived science. A. E. C.

The Social Measures of Education. L. D. COFFMAN. *Wash. Educ. J.*, **7,** 143 (Jan., 1928).—The present tendency is to evaluate education in terms of immediate results, but the true evaluation should be made thirty years after graduation. An educated generation should show then (1) an increased earning power over a generation that has not had the same opportunities in education, (2) better health, (3) greater happiness, (4) better citizenship, (5) a higher, finer, and worthier sense of moral and spiritual value. Education has already helped to increase the earning power and the wealth of our people. Through the schools, the way to utilize this wealth and health may be pointed out to all the youth of this generation. A. E. C.

Another Degree? A. D. WEEKS. *Sch. and Soc.*, **27,** 48–9 (Jan. 14, 1928).—Mr. Weeks advocates the creation of another non-professional degree, Co.S. (College Student, or Collegiate Status), and its conferment on any individual who satisfactorily completes any course in an established institution of collegiate rank.

If the above were the case many thousands, to whom the idea of college work is now foreign, would take advantage of the opportunity which higher education offers. K. S. H.

Faculty Advisers of Students and the Personnel Office. E. S. JONES. *Sch. and Soc.*, **27,** 79–81 (Jan. 21, 1928).—Dr. Jones sets forth the advantages and disadvantages of having faculty advisers for students, showing how lightly some advisers take this responsibility; how some men use this as a means of building up large courses in the departments they represent; how some scarcely know their advisees. He discusses the advantages of having a personnel department in a college, and pictures an ideal condition where the faculty adviser and the personnel office would coöperate, but where final decisions would be made by the students themselves. He concludes his article by stressing the fact that, despite its defects, the system of faculty advisers should be maintained. K. S. H.

Science and the Humanities. EDITORIAL. *Sch. and Soc.*, **27,** 97–8 (Jan. 28, 1928).—Summarizing Sir Richard Gregory's address, delivered at the annual meeting of the British Science Master's Association, the *London Times* says that teachers of English have as much need of lessons in science as science teachers have need for courses in language and literature. Cultural effort would gain more power and a new meaning if the human contacts of science were understood and interpreted with other subjects. K. S. H.

A Change in Admission to the Medical School. EDITORIAL. *Mich. Alumnus*, **34,** 306 (Jan. 14, 1928).—Owing to the fact that between four and five times as many students apply each year for admission to the Univ. of Mich. Medical School as may be admitted, some scheme for selection is necessary. The Board of Regents has approved the following plan. Each candidate for admission will be interviewed by members of a committee composed of the Dean and two faculty members. The candidate must also write an answer to a question intended to test his ability to reason and to write English. No longer will the selection be based upon academic record alone. E. R. W.

The Manufacture of Artificial Silk with Special Reference to Viscose. H. R. S. CLOTWORTHY. *Chem. & Ind.*, **47,** 24–30 (Jan. 13, 1928).—A very readable article, well illustrated, describing the different processes by which artificial silk is made from cotton, paper, and wood pulp. In the viscose process, which is the most used at the present time, the cellulose is first mercerized by treatment with sodium hydroxide. Carbon disulfide is then added, converting the material to cellulose xanthate which

is then dissolved in dilute alkali and precipitated in the form of threads in dilute sulfuric acid. E. R. W.

The Remuneration and Duties of Professors. EDITORIAL. *Chem. & Ind.*, **47**, 55 (Jan. 20, 1928).—With Professor W. L. Bragg, the editor believes that too much importance is attached to examinations in colleges and universities. It is suggested that part of these examinations, at least for the more advanced students, may be profitably replaced by small research problems; "... hardly a page in *Roscoe & Schorlemmer*, hardly a paragraph in *Mellor*, that does not provide enough research to last an enquiring mind for many years." The student should do his own thinking, thus acquiring ability that will be of much help in later life. There should be closer contact between college faculties and industrial concerns and coöperation in the choice of research problems. Such mutual understanding and interests would result in better teaching, better trained men for the industries, and better remuneration for those who do the training. E. R. W.

Development and Progress of the Alkali-Chlorine Industry. D. A. PRITCHARD. *Chem. & Ind.*, **47**, 57–60 (Jan. 20, 1928).—In this article the development of the Le Blanc, Solvay, and electrolytic processes in the United States and in Europe is outlined and discussed in some detail. The continued spread of the electrolytic process for the preparation of alkali is dependent upon a market for the by-product, chlorine. E. R. W.

Carbon Dioxide and Its Manufacture in Canada. J. R. DONALD. *Can. Chem. and Met.*, **12**, 3–7 (Jan., 1928).—Contains an account of the properties, uses, and development of carbon dioxide manufacture from the acid treatment of a carbonate, the decomposition of carbonates by heat; the coke process where the carbon dioxide is absorbed by potassium carbonate and the carbon dioxide obtained by heating the bicarbonate; to the more recent method of obtaining it from fermentation processes. This process is made possible by the use of activated charcoal for the removal of objectionable odors, one pound of activated charcoal purifying 16 lb. of carbon dioxide. In beverages there is a large decrease in the bacterial count several days after the water has been carbonated. In addition to its uses in refrigeration, beverages, and fire extinguishers, it is used in packing certain products where the presence of air is deleterious, such as shredded cocoanut, some tobaccos, and coffee. It has found some uses in being beaten into butter and ice cream. Other possible uses are in the removal of boiler scale and stimulation of plant growth. Its high and continuous pressure is often utilized in clearing pipes, testing apparatus, locating holes in tubes, and operation of paint sprays. D. C. L.

Culture and Chemistry. EDITORIAL. *Nature*, **121**, 161–2 (1928).—Professor H. E. Armstrong lectured before the Royal Society of Arts on "Marcelin Berthelot and Synthetic Chemistry," not only describing the life and work of the man but placing his accomplishments historically and in the scheme of progress. A. has no use for our present scheme of chemical education, but though it is far from perfect it should not be thrown over entirely for that reason. Perhaps the large amount of poor work is due to a large number of poor workers submerging the work of better men. Berthelot's pioneering was in the field of synthesizing organic compounds. We have probably gone too far in following in his path, but, as Mr. Robert Mond suggested at the close of Prof. Armstrong's talk, in chemistry one can check one's own errors and, therefore, the subject may be made an excellent tool for moral training. T. M. M.

Spontaneous Generation under the Imperium. J. G. WOLCOTT. *Educ. Rev.*, **75**, 53–6 (1928).—The utilization of our present sources of energy is progressing at such a rapid pace that there is rather imminent danger of their exhaustion. W. believes that the teacher, like the Roman military commander, "holds the imperium needed for governing the expenditure of our resources." The problem is to tap new sources of energy, such as the daily supply of sunshine, the internal heat of the earth, and the energy of the atom, and until such sources are available to conserve those now being wastefully consumed. Such control of waste can only be carried out through existing political government. The teacher, seeing this problem, has it in his power to influence those under his imperium to use their powers for the greatest good to the community and the world. There remains the problem of how to make men and governments agree to coöperation for the purpose of logical progress while racial prejudices exist. Like Kekulé with his inspirational realization of the concept of the benzene ring, W. seized on the idea of governments being a forum of energy of the human race, "occupied with the manipulation of total energy." When men see that only through coöperation of governments can energy be conserved for the preservation of the race, they will be supplied an inducement to universal action. T. M. M.

Local Activities and Opportunities

Cincinnati Section, A. C. S. The 297th regular meeting of the Cincinnati Section of the American Chemical Society was held in the Chemical Auditorium of the University of Cincinnati on March 13th.

The speaker of the evening was Dr. Victor K. LaMer, professor of physical chemistry at Columbia University. He presented a paper on "The Behavior of High Valence Ions in Aqueous Solution."

Dr. LaMer has just recently returned from Europe where he obtained first-hand information on research in this field.

Cleveland Section, A. C. S. The March meeting was held in The Cleveland Engineering Society rooms in Carnegie Hall on March 9th.

Speaker: Dr. Victor K. LaMer of Columbia University.

Subject: "The Influence of Electric Charges on the Behavior of Solutions, Particularly Solubility."

The meeting was preceded by a dinner at the Bohanon & Haines Restaurant.

University of Pittsburgh. Professor Alexander Silverman, head of the department of chemistry of the University of Pittsburgh, delivered an illustrated lecture on "Glass" before the Erie Section of the American Chemical Society, Monday, March 12th.

Central Pennsylvania Section. On March 27th, Dean W. A. Pearson of the Hahnemann Medical College, addressed the Section on the "Biological Testing of Drugs." On May 2nd, Dr. J. Bennett Hill of the Atlantic Refining Company, Philadelphia, Pa., will speak on "Recent Developments in the Petroleum Industry." The Section is planning to hold a meeting at Bucknell University, Lewisburg, Pa., during the month of May.

Georgetown University. Georgetown University received on March 9th a gift of $250,000 in cash from Mr. and Mrs. Thomas J. Maloney of Waldwick, N. J., towards the establishment of a Chemo-Medical Research Institute. The proposed Institute will be adjacent to the new medical school buildings, plans for which are rapidly nearing completion.

University officials in making the announcement state that the purpose of the Research Institute is to investigate the basic causes of disease. The plans provide for an endowment of $4,000,000 of which the Reverend Geo. L. Coyle, S. J., Director, has obtained pledges for $2,500,000. With the donation of Mr. and Mrs. Maloney the cash contributions to date total $300,000. Mr. Maloney is a retired business man and was formerly President of the American Tobacco Company. Father Coyle, Dean of the Chemistry Department of Georgetown, has been conducting a campaign for the Institute which is proposed to carry out the recommendations made by a committee of nine of the most eminent scientists for the American Chemical Society.

On February 3rd, at the first public meeting of the month for the Chemistry Academy of Georgetown University, the guests and members were privileged to listen to a very interesting lecture delivered by Dr. F. C. Whitmore, head of the chemistry department of Northwestern University and at present serving as Chairman of the Division of Chemistry and Chemical Technology of the National Research Council.

Dr. Whitmore chose for his topic of discussion "The Habits of the Atoms." He entered the field of physical chemistry and treated the intricate subject of atomic numbers and atomic structure in a most interesting manner. The lecture was well

received and highly appreciated by the guests and members.

On February 15th the "Story of Sulfur" and the "Story of a Mexican Oil Gusher," two very interesting films, were exhibited before a large gathering. At the next meeting, February 28th the following films were exhibited for the members of the Academy: The Story of Copper Milling, Copper Smelting, and Copper Refining. The meeting was very well attended and the pictures were enthusiastically received. March 6th, the Academy held its next public meeting and the guests and members were accorded the pleasure of listening to a very learned and interesting discussion delivered by Dr. M. X. Sullivan of the U. S. Hygienic Laboratory. This was Dr. Sullivan's second appearance before the Georgetown student body. Last year he spoke on "Sulfur in Its Relation to the Defense Mechanism of the Body." This year the speaker chose as his subject "Chemistry and Health." His lecture was a masterpiece and was highly appreciated, meriting at its close the outward spontaneous display of approval.

University of Pittsburgh. The department of chemistry of the University of Pittsburgh will offer an entire year's course in chemistry during the summer of 1928. The courses offered include inorganic, organic, analytical, and physical chemistry. By working from 8 to 1 daily, Monday to Saturday inclusive for eight weeks, and devoting his time entirely to chemistry, the student is able to meet the college-year requirement in course. Afternoons and evenings are free for study and recreation. These courses are offered for the benefit of students who wish to advance themselves more rapidly by doing summer work and for teachers who wish to review their subjects in a thoroughly up-to-date manner. Courses will begin July 2nd.

A course in quantitative organic microanalysis has been instituted in the department of chemistry of the University of Pittsburgh. Instruction will be given in the following determinations on minute amounts of organic compounds: carbon and hydrogen, nitrogen (Dumas and Kjeldahl), halogens, sulfur, phosphorus, metals in salts, carboxyl,methoxyl, methyl groups attached to nitrogen, micro-electro-analysis and molecular weight. Attention will also be paid to the technic involved in the purification and study of minute amounts of organic substances.

The course will be in charge of Dr. R. T. K. Cornwell, a student of Professor Fritz Pregl.

Connecticut College of Pharmacy. The appointment of Professor Henry S. Johnson to be Associate Dean of the college has recently been announced by the Board of Trustees. Professor Johnson has been in charge of the chemistry department at the college since it was instituted three years ago. Prior to that he was professor of organic chemistry at the University of Porto Rico. Dr. Gustavus Eliot will continue as Dean but will be assisted in the future by Professor Johnson.

On January 26, 1928, the Connecticut College of Pharmacy was registered by the Board of Regents of the University of the State of New York, so that graduates of the three-year course may take examination for license in that state. This is an important event in the history of the young institution.

Lexington Section, A. C. S. The Lexington Section of the American Chemical Society held its 126th regular meeting on the afternoon of Tuesday, March 13, 1928. The section had previously offered prizes to the writers of the three best essays submitted by students in Lexington high schools for competition in the National Prize Essay Contest conducted by the American Chemical Society. These essays were read and prizes awarded at this meeting. First prize was awarded to Eldrid Calkins, second to George Roberts, and third to Elizabeth Poole. The meet-

ing was well attended, not only by the regular members but by many of the townspeople.

Carnegie Institute of Technology. Continuing its program of scientific research in coöperation with the United States Bureau of Mines and two advisory boards representing the mining and metallurgical industries, the Carnegie Institute of Technology will award ten fellowships in mining and metallurgical research during the coming year.

Fellowships are open to the graduates of colleges, universities, and technical schools who are qualified to undertake research investigations. The investigations will be made under the supervision of representatives of the Pittsburgh Station of the U. S. Bureau of Mines and members of the faculty of Carnegie.

Several of the fellowships will be financed by companies and organizations representing the mining and metallurgical industries. In addition, the members of the advisory boards will assist in promoting the work and in publishing the results of the investigations. Thirty-six bulletins reporting results of separate studies have already been published since the coöperative research was started several years ago, and four more published reports will be be available before the end of the summer.

Appointments to the ten new fellowships will be made during the spring and early summer months, with the preliminary investigations of the new program scheduled to begin in August.

Subjects for research by the fellowships appointed for 1928–29 will be selected in the fields of "origin and constitution of coal," "coal mining," "utilization of coal," "mine safety," and "physical chemistry of steel making."

Courses for teachers are receiving special attention in the plans for the Eleventh Summer Session of the Carnegie Institute of Technology in Pittsburgh. The work offered includes a variety of subjects of interest to teachers and supervisors of public school music, art, and manual and industrial arts.

The courses for teachers will be given for six- and eight-week periods beginning June 11th and June 25th. Courses for undergraduates will extend for eight weeks from June 11th to August 3rd. The program for both groups will include work in the College of Engineering, College of Industries, College of Fine Arts, and the Division of General Studies.

As a new feature in connection with the plans for the coming session, the announcement points out, certain shop and studio courses for teachers have been made more flexible both in hours scheduled and amount of credit obtainable by offering them in periods of either six or eight weeks' duration.

University of Delaware. The University of Delaware has available one fellowship, the duPont Fellowship ($300) and also several Assistantships in Chemistry.

Wesleyan University of Middletown, Connecticut, usually assigns annually 4 assistantships paying $600 for the first appointment and $800 for a second appointment. These positions carry exemption from tuition and fees. There is an industrial fellowship of approximately the same value. The chemistry department also has the privilege of naming a full-time worker at approximately $100 a month, who aids the departmental staff in investigations carried out with the cooperation of the State Water Commission.

R. I. State College. The fifth Annual Chemistry Contest conducted by the Chemistry Department of Rhode Island State College, will take place at Kingston, May 12th. The contest is open to all Rhode Island high schools and will be conducted on the same basis as previously.

Detailed information regarding these contests and copies of the tests used will be mailed to any persons requesting them.

The questions are unique and interesting in as much as they are illustrations of the new type, being one hundred in number and covering the maximum college entrance requirements in chemistry.

Recent Books

Mathematical Preparation for Physical Chemistry. FARRINGTON DANIELS, Associate Professor of Chemistry, University of Wisconsin. McGraw-Hill Book Company, Inc., New York and London, 1928. First edition. x + 308 pp. 65 figures. 20 × 14 cms. $3.00 net.

"It is because the author has seen so many students struggling against the handicap of an inadequate preparation in mathematics—spending more effort in avoiding mathematics than needs to be spent in learning it—that this book has been written. . . . Its only prerequisites are a little knowledge of algebra, a speaking acquaintance with trigonometry and an interest in chemistry. . . . It is *not* equivalent to the standard courses in analytical geometry, differential calculus and integral calculus. . . . The material of this book is sufficient mathematical preparation for a first course in physical chemistry and for some advanced courses. . . ." ". . . the author. . . hopes that many who read these pages will resolve to go farther in the study of mathematics."

In such words Professor Daniels states the purpose of his book. Many teachers of chemistry have sighed for a course in higher mathematics that would really meet their particular needs, a few have themselves introduced such a course, but very few have had the courage to write a book embodying their ideas. It is the reviewer's opinion that Professor Daniels has not only done what his preface states, but he has done it exceedingly well. Within such a bulk as to be a text and not a reference book, he has presented the fundamental and necessary ideas of physical chemical mathematics quite thoroughly. Furthermore, he has done it so interestingly that it will be an unimaginative reader who is not urged to go on. One ventures the prediction that many teachers will now find time to offer such a course with this book as the text.

In twenty-one chapters the author discusses the following subjects: large and small numbers, logarithms, the slide rule, graphical representation of equations, graphs of equations of the second degree, graphs of logarithmic and trigonometrical functions, differential calculus, differentiation, graphs and calculus, the differential integral calculus, the significance of "e," differentiation and integration of trigonometrical functions, integration, the use of integration tables, geometrical application of integral calculus, partial differentiation, differential equations, infinite series, probability, graphical methods in physical chemistry. The book includes five appendices covering: physical chemical problems, definitions of advanced terms, a bibliography, theorems of elementary mathematics, and eleven tables. Following each chapter there is also a very generous selection of problems for every other one of which the answer is furnished. The reviewer wishes to commend especially the fact that well over fifty per cent of all the problems in the book are eminently practical from the chemist's viewpoint. How interest is aroused by this is obvious.

In conclusion, this book is very interesting and is very useful. It is a long step in the right direction.

MALCOLM M. HARING

General Chemistry. THOMAS P. MCCUTCHEON, Professor of Inorganic Chemistry at the University of Pennsylvania and HARRY SELTZ, Assistant Professor of Physical Chemistry at the Carnegie Institute of Technology. D. Van Nostrand Company, Inc., New York City, 1927. x + 415 pp. 33 figs. 22.2 × 14.5 cm. $3.50.

The book is attractively but not any too substantially bound. The page type is 10 on 12 and the problems 8 on 10 Caslon old face with antique section and side heads. The paper is good although it does not take common writing ink very well. The entire volume suffers seriously from either broken or poorly impressed type. There are numerous typographical errors throughout the book, thirty-one of which are in the index.

Apparently the book is designed for all first-course college chemistry students, regardless of their previous contact with the subject in the high school. It is organized in two parts: I. Theoretical Chemistry (162 pp.); and II. Descriptive Chemistry (226 pp.). This two-phase arrangement suggests "Work first and play afterward." It is an excellent rejuvenation of a similar one used by an author in the latter part of the 19th century. Judging from the "Syllabus of Lectures" on page vi, the authors intersperse the chapters from Part II with those in Part I to meet their own needs and desires.

It would seem that the authors have a keen appreciation of the enormous volume of descriptive chemistry which is often foisted on the first-course student. With this and certain other facts (see preface) in mind they have included very little historical material and have made industrial process descriptions extremely concise.

Part I affords one of the most compact and at the same time generally satisfactory treatises on elementary physical chemistry of any of present-day vintage. In quite a few passages, highly erroneous impressions are likely to result from the brevity of the treatment. A few examples are: (1) "A compound is represented by a formula, made by placing side by side the symbols of its constituent elements" (p. 4); (2) from their picture of an atom (p. 6), uranium has an atomic weight of 92; (3) "The oxygen standard is more convenient since a great number of elements then have atomic weights which are very nearly whole numbers" (p. 23); (4) "If a non-volatile (solid) solute is introduced, the molecules of the solute interfere with the escape of the solvent molecules, thereby decreasing the vapor pressure" (p. 59); (5) from the discussion of "Order of Reaction" (p. 79) the reader might infer that the number of unimolecular reactions is somewhat large; (6) on page 80, the statement is made that "Most reactions are not of this type" (irreversible), nevertheless, very few of the chemical equations in the book are written with the reversible sign.

The authors have used definitions very sparingly, a position which might be justified only for more advanced students as definitions are dangerous. It is regrettable that the spelling of sulfur throughout the book is not that used in the publications of The American Chemical Society. A few cuts of chemists, etc., would add to the human side of the volume.

J. E. DAY

Outline of the History of Chemistry. NORRIS W. RAKESTRAW. Published by the compiler, Brown University, Providence, R. I. Two wall charts on cloth, 83 × 149 cm. $10.00 a pair; on paper, 25.5 × 43 cm., 50 cents a pair.

Slosson's aphorism to the effect that history may be compared to a chauffer's mirror on an automobile in that we look backward in order to see what is coming forward is especially applicable in the case of the history of chemistry. Professor F. J. Moore, in the preface to his admirable little book on the subject has clearly stated the advantages of a knowledge of the work and methods of thought of our chemical forefathers. The interested student, however, wishing to go deeper into the subject, is apt to become lost in the labyrinthian passages along which the science has developed, and welcomes a thread of Ariadne to lead him through the maze. Such a

thread he finds in these charts with their flow lines, which serve to connect related subjects and persons. Marginal references to British sovereigns and American presidents help to fix periods of time. The very completeness of these charts is their sole drawback for there is so much material incorporated in them that it is difficult at times to follow the connection.

COLIN M. MACKALL

The Phase Rule and Its Applications. ALEXANDER FINDLAY, M.A., D.Sc., F.I.C., Professor of Chemistry, University of Aberdeen. Longmans, Green & Co., New York and London, 1927. Sixth edition. xv + 326 pp. 165 illustrations. 21 × 14 cm. $3.50 net.

Twenty-four years ago Professor Findlay wrote, "the desire having been to explain as clearly as possible the principles underlying the Phase Rule, and to illustrate their application to the classification and investigation of equilibria, by means of a number of cases actually studied." He expressed also his desire to make the book elementary enough for the beginner while retaining such a thoroughness of treatment as to give him a really satisfactory foundation in the subject.

How well he has attained his object, the use of the book by thousands of teachers abundantly attests. One planning to give a course in "Phase Rule" instinctively thinks of "Findlay" as his text. This sixth edition will still further confirm all users in this thought.

Twenty-eight pages have been added since the fifth edition. This does not seem so much, but the real excellence of the new edition lies in the choice and arrangement of material. Many sections have been entirely rearranged and rewritten, notably the sections on one- and two-component systems, with considerable increase in utility and clarity thereby. The practical applications of the subject have been stressed more than ever. The sections on reciprocal salt pairs and salts with a common ion have been considerably expanded and improved. Smits' theory of allotropy and the nature of the equilibria in intensively dried systems are discussed briefly.

One feels that the applications in metallography and geology might profitably be expanded somewhat. Also the wisdom of dropping the chapter appearing in former editions on blast furnace equilibria is to be doubted, although real criticism along this line is unfair. One must draw the line on material to be included somewhere. The reviewer notes with satisfaction the much more extensive discussion of the Clapeyron-Clausius equation and its application to phase transformations. It is possible to repress mathematics too far in such a work. In fact it seems a pity that a really satisfactory derivation of the phase rule itself has not as yet been included.

MALCOLM M. HARING

Exercises in General Chemistry. CHARLES M. ALLEN, M.A., Head of the Department of Chemistry, Pratt Institute. John Wiley & Sons, Inc., New York City. Second edition. 1927. 63 pp. 20 × 26 cm. $1.75.

This book consists of sixty-two experiments covering first-year chemistry. The directions are given clearly with explanations when necessary, together with the necessary precautions. The text contains an entire page of laboratory directions, which are omitted from most texts because they appear too obvious, with the result that the student becomes familiar with them only by the end of the term. The attention of the student is called to the things to be observed by questions throughout the procedure, while questions of a general type appear at the end of each experiment. The manual carefully avoids imparting information which a student can obtain for himself. The experiments in most cases are well selected, but distillation might be carried out more conveniently with a flask than a retort.

The type is of good size, clear and printed on loose leaves, well secured in a

heavy cardboard cover so that the effect is very much that of a regular binding. The arrangement of the work in each experiment is such that it could conveniently be used to accompany any one of a number of texts.

D. C. LICHTENWALNER

Leaves from the Notebook of the Chemist. A series of eight radio talks (with selected bibliographies). Radio Publication No. 35. University of Pittsburgh, Pittsburgh, Pa., 1928. 73 pp. 15 × 22 cm. 60 cents.

The titles of the talks included are as follows:

I. "The Chemist's Job and How He Goes about It," Gebhard Stegeman.
II. "Grinding Away: Abrasives," James N. Roche.
III. "New Protective Coatings," Wilmer E. Baldwin.
IV. "Making Pictures: After the Snapshot," E. V. Hjort.
V. "Like Ivory and Amber: Condensation Products," Ralph T. K. Cornwell.
VI. "Approved Food Colors," C. G. King.
VII. "Making Medicines," Alexander Lowy.
VIII. "Radium: From Watch Dial to Hospital," Alexander Silverman.

A list of the University of Pittsburgh radio publications to date is appended. Others of interest to the teacher are as follows:

No. 5 *The Rôle of Chemistry in Everyday Life* ($0.15).
No. 6. *The Rôle of Chemistry in Everyday Life* ($0.50).
No. 9. *Science in Industry* ($0.60).
No. 21. *Chemistry and Human Progress* ($0.60).
No. 23. *Science in the Home* ($0.75).

A CORRECTION

In the February number, page 241, the price of the Hedges and Brayton's "Laboratory Manual of Inorganic Chemistry and Elementary Qualitative Analysis" (D. C. Heath and Co.), was erroneously given as $2.50. The correct price is $1.48.

Glucose Helps Acute Encephalitis Cases. The treatment of encephalitis by the injection of glucose has awakened considerable interest among specialists at St. Elizabeth's Hospital for the Insane. Dr. Walter Freeman, who has made many researches on encephalitis, declares "that even though the way in which it works is uncertain, this mode of treatment undoubtedly offers something of importance in the treatment of nervous diseases."

The first clue to the beneficial action of glucose, according to Dr. Alford, came from its administration as nourishment to an encephalitis patient who was delirious and refused food. This took place in November, 1926. To the surprise of everyone the patient began to improve. On Christmas day she recovered her senses and by New Year's Day returned home and has remained well ever since. Glucose seemed the most probable factor in this unprecedented recovery and so was given a trial in another acute case which likewise registered rapid improvement.

The method was followed up with good results in as many as forty acute cases. The injections have no harmful effects, it was stated. It has, however, brought about only slight improvement in chronic cases. The chronic form of encephalitis is particularly stubborn and to date few ways have been found of combating it.

It will be many years, Dr. Freeman pointed out, before the glucose treatment can be properly evaluated but, he added, any method that gives hope of relief in dealing with this unfortunate disease is worthy of trial and further research.—*Science Service*